soldiers or sailors at the front. No wrapping. No address.

AVIATION AND AERONAUTICAL ENGINEERING

International Film Service — A British Airplane in Palestine

EPTEMBER
15th
1917

SPECIAL FEATURES

VIBRATION OF A ROTATING AIR-SCREW AND ITS SHAFT

NIEUPORT 1½ PLANE FIGHTER

THE 260 HP. MERCEDES AERO-ENGINE

COMPLETION OF THE LIBERTY ENGINE

REVIEW OF THE FOREIGN AERONAUTICAL PRESS

PRICE
Fifteen
Cents

PUBLISHED SEMI-MONTHLY
BY
THE GARDNER, MOFFAT CO., Inc.
120 W. 32nd ST. NEW YORK

CONTRACTORS TO

The United States Army and Navy

The British Admiralty

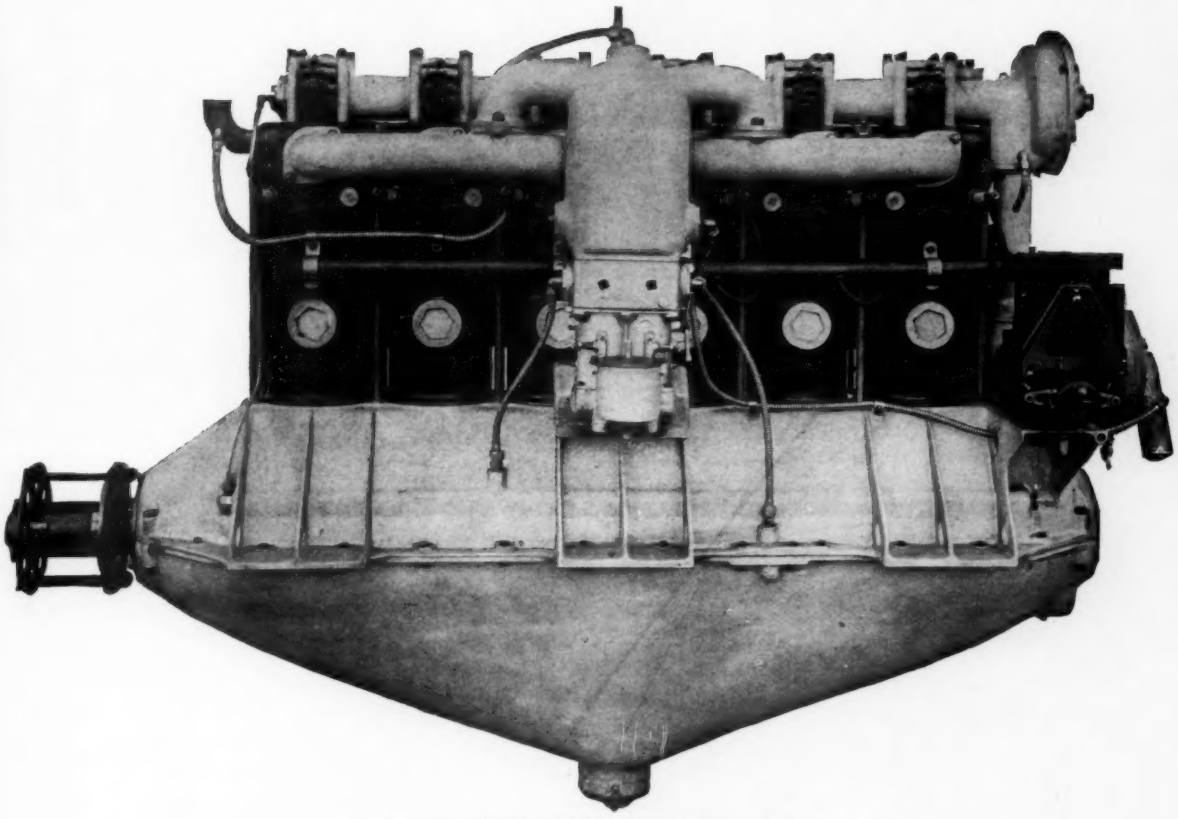
THE BURGESS COMPANY

MARBLEHEAD, MASS.

Sole Licencees for the United States for the Dunne Patents

Member of the Manufacturers Aircraft Association, Inc

HALL-SCOTT



Intake Side Hall-Scott, "BIG SIX" Airplane Engine

This Hall-Scott, Type A-5a, rated at 150 H.P., is offered after having most successfully passed severe running tests as required by Hall-Scott engineers, and final 48 hour endurance, running test, on cradle type torque stand, with propeller directly connected, in accordance with U. S. Government requirements. (Spec. 1002.)

Total weight, complete and ready for service,	*578 lbs.*
Weight per H.P. (Based on actual H.P. development, at 1,300 R.P.M.)	*3.61 "*
Consumption gasoline in lbs. per H.P. hour,	*.565*
" lubricating oil " " "	*.025*

HALL-SCOTT AIRPLANE ENGINES, both four and six cylinder types, are used by U. S. Army and Navy Departments, and are generally used by all leading American airplane manufacturers.

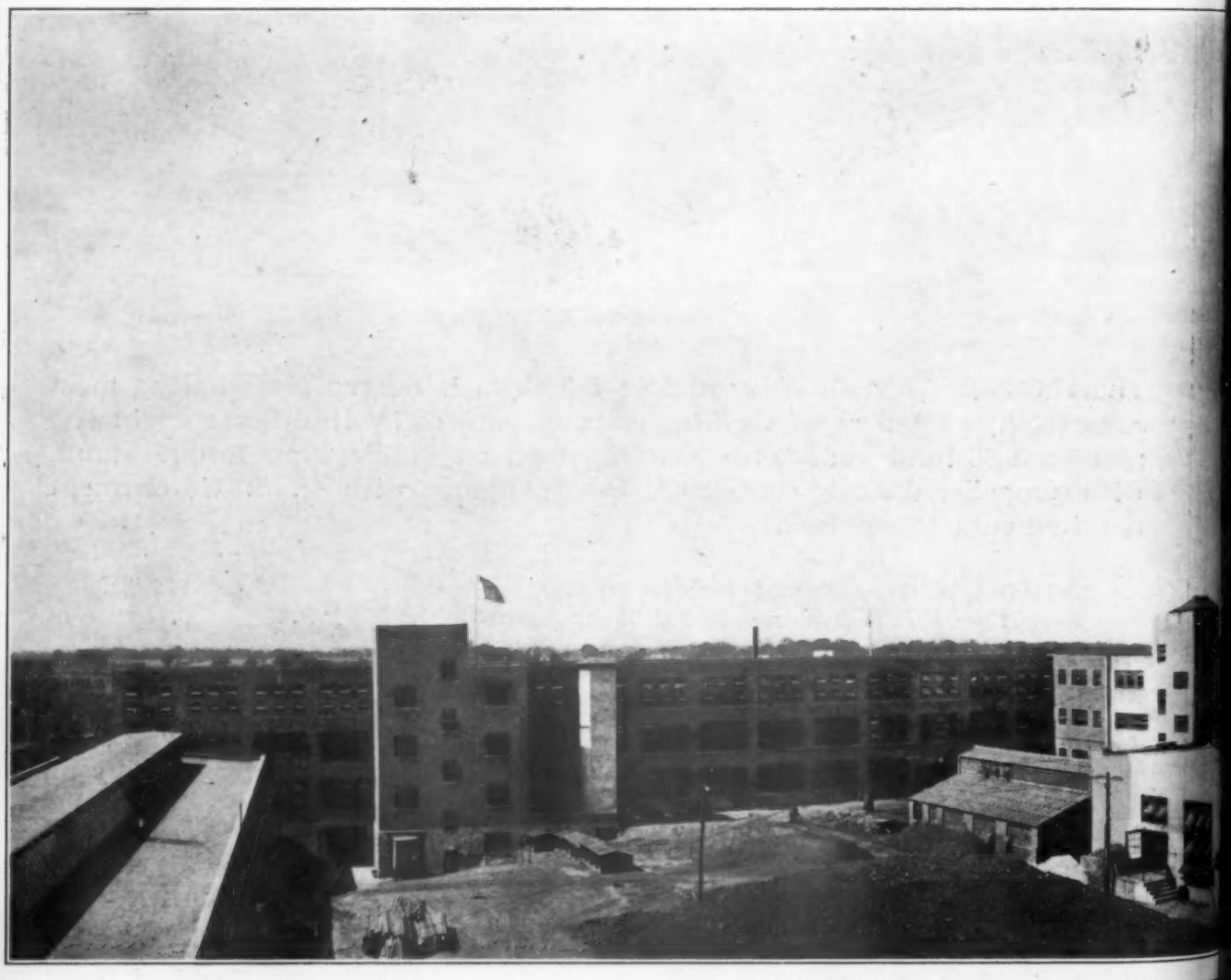
Hall-Scott Motor Car Co., Inc.
General Offices
Crocker Bldg., San Francisco, Calif.

F. P. Whitaker
EASTERN REPRESENTATIVE
165 Broadway, New York City

Member Manufacturers' Aircraft Association, Inc.

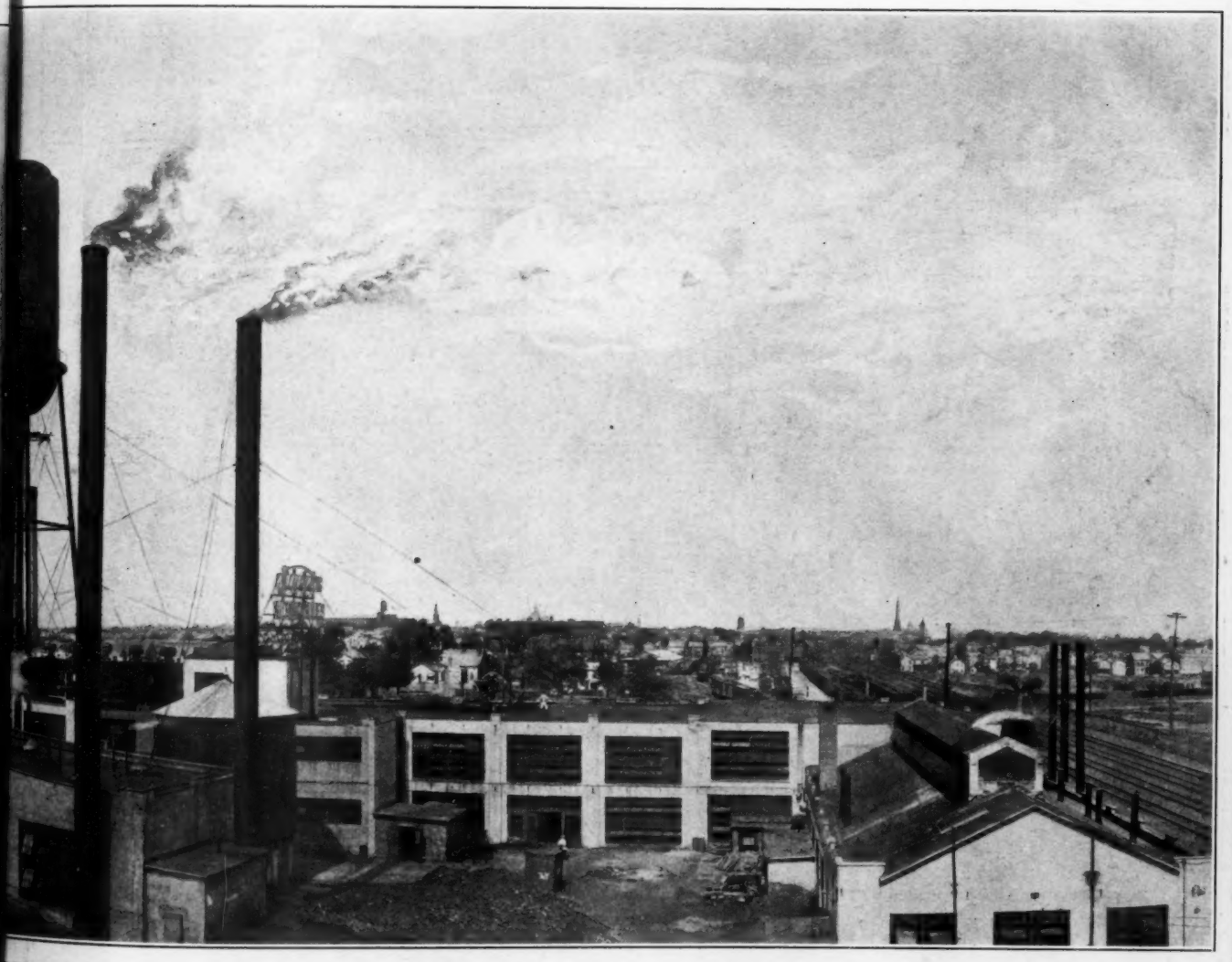
Wrigh

Aircraft

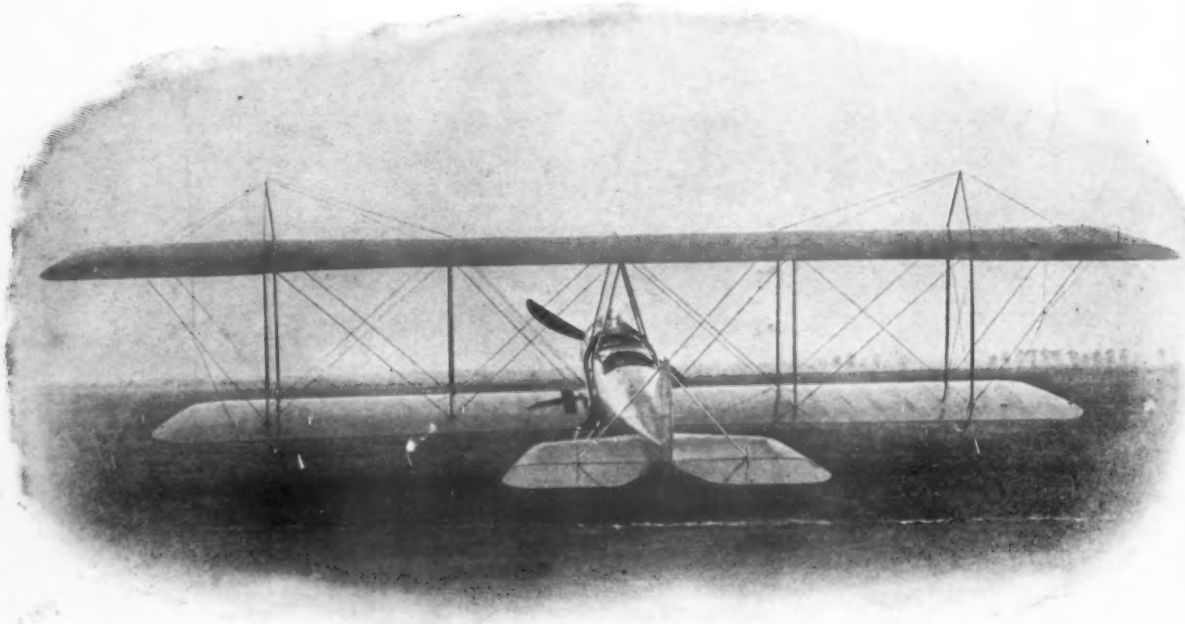


NEW BRUNSWICK

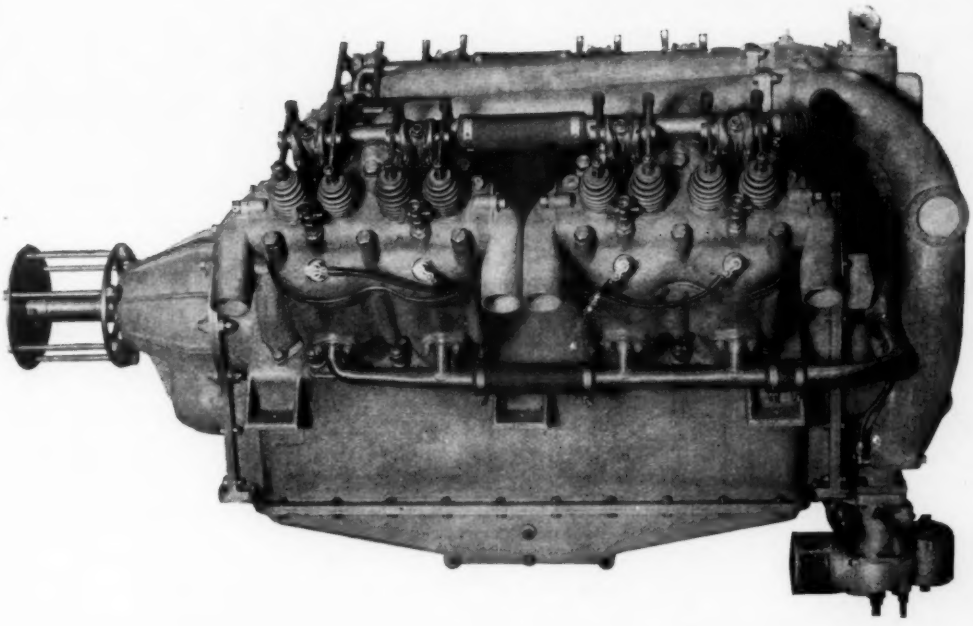
Martin
rporation



ERSEY FACTORY



·L·W·F·ENGINEERING·COMPANY·
Member, Manufacturers' Aircraft Assn., Inc.



2 4/10 POUNDS PER HORSEPOWER

We announce our latest airplane engine
Model 5A-4½, 8 cylinder
Equipped with Sturtevant Thermostat
for control of temperature
And Sturtevant Automatic Altitude Compensating
Attachment for carburetor

HORSEPOWER 210 **WEIGHT 508 POUNDS**

Deliveries can be made in three to four weeks.

Sturtevant
(REG. U.S. PAT. OFF.)

B. F. STURTEVANT COMPANY

HYDE PARK, BOSTON, MASSACHUSETTS.

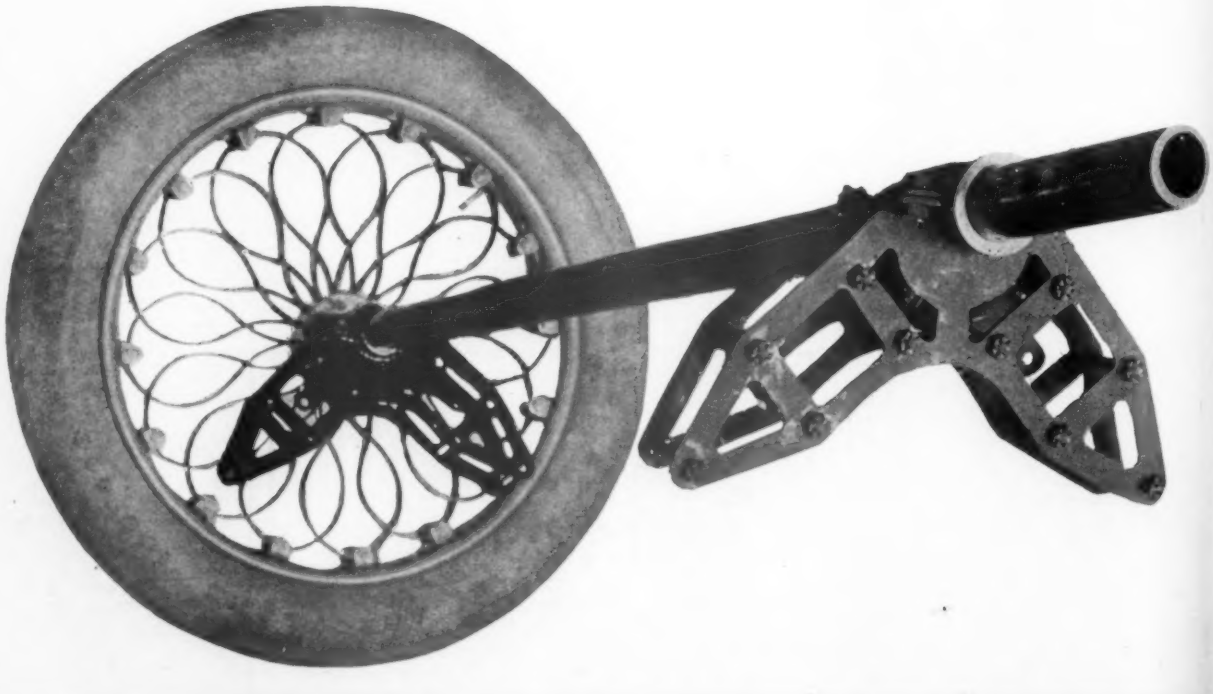
LOGICAL EQUIPMENT

Official Government tests at the Bureau of Standards have shown that ACKERMAN WHEELS will successfully resist all the ordinary compression and side thrust shocks to which the landing gear of the modern airplane is subjected and that they have greater reserve power to meet extraordinary loads.

Constructors can greatly simplify the complex problems of landing gear design by the adoption of rigid axles with ACKERMAN WHEELS and at the same time insure a better landing support for the airplane.

The spring action of the wheel absorbs all shock before it reaches the axle, prevents rebound and makes

SHOCK ABSORBERS UNNECESSARY



THE MODERN AIRPLANE

The most severe tests and actual field practice have proven the correctness of the statement that ACKERMAN WHEELS are *logical equipment* for the modern airplane.

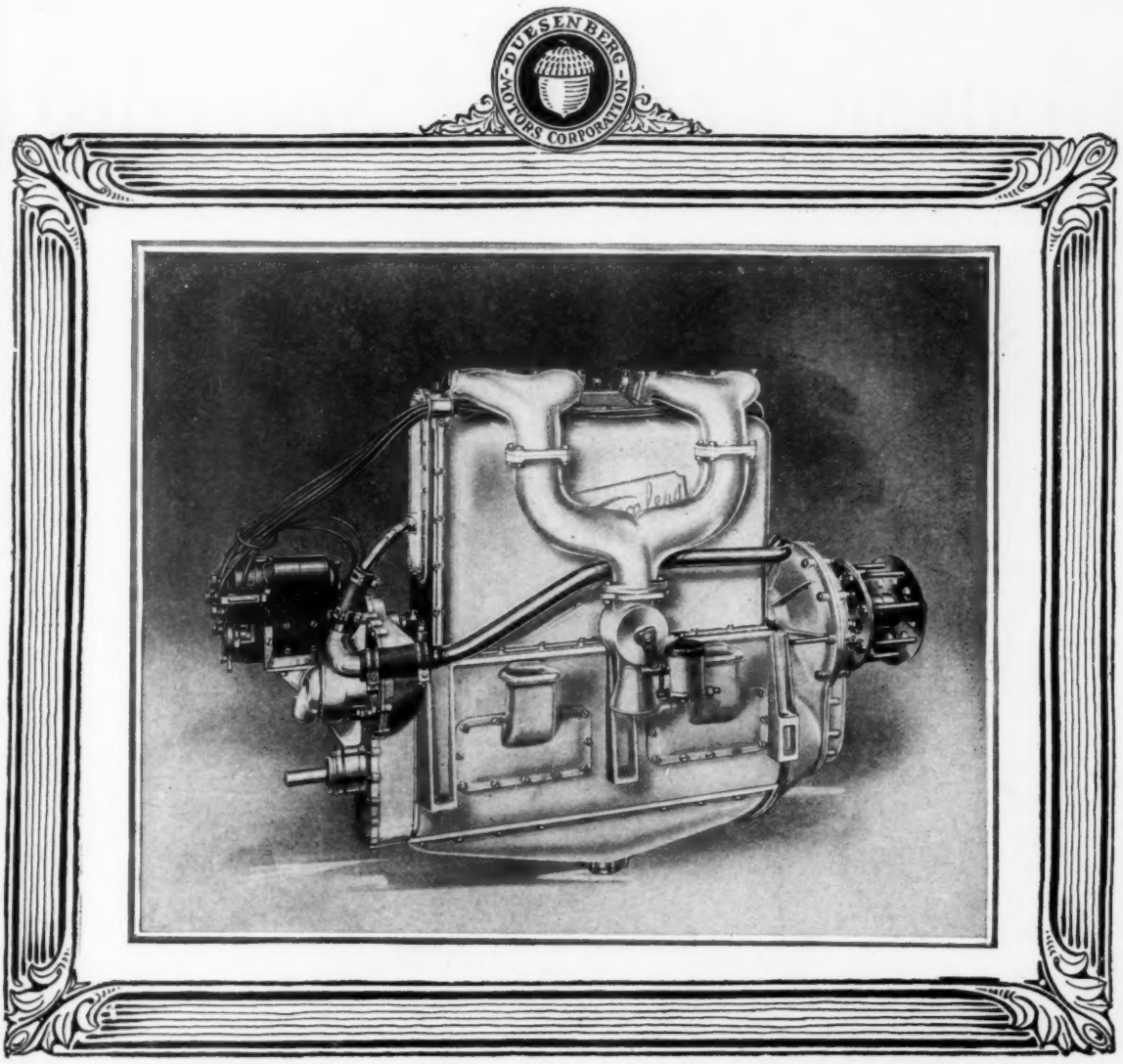
Wheels built for any weight machine from 500 pounds up.

The ACKERMAN WHEEL COMPANY

ROCKEFELLER BUILDING - - - - CLEVELAND, OHIO

Aéroplanes
VOUGHT

LEWIS & VOUGHT CORPORATION
WEBSTER AND 7th AVENUES,
LONG ISLAND CITY, N. Y.



Duesenberg Airplane Engine

BACK of all successful motors there is a reason why. This is particularly true of the Duesenberg Airplane Engine, which is the evolution of the world-famous Duesenberg Automobile Racing Motor that has created new standards for motor construction and motor accomplishments.

Away back, in the year 1900 to be exact, the original Duesenberg Design had its inception. In a tiny garage and repair shop in Rockford, Iowa, two very earnest and two very poor young men, Mr. Fred. S. Duesenberg and his brother Mr. A. S. Duesenberg, built their first gasoline motor, a clumsy little motor cycle engine that was exhibited at the first Chicago Automobile Show. Even in these formative days their motor gave promise of a budding genius in design which has been fully realized in these later years.

Catching a glimpse of the possibilities offered in the Automobile Field, the Duesenberg Brothers designed various engines for automobile purposes and eventually graduated into the automobile racing field, as it offered the quickest method of trying out and testing new motors.

Their first big race was Indianapolis in 1912, from then on until to-day the Duesenberg engine has broken record after record on the racing tracks, has caused revision after revision of rules. Duesenberg Design, backed by the conviction, dogged pluck and unbreakable optimism of two men, came up from under and dominated the entire field of high speed, high powered automobile motors. All this was done without financial backing and with practically no factory facilities and in direct competition with the biggest and most efficient engine building organizations in the world.

To-day it is possible to buy an Airplane Engine evolved from this automobile racing motor. An Airplane Engine that sets new standards in its field also.

Duesenberg Motors Corporation

120 Broadway, New York City

Airplane Propeller Specialists

Propellers for airplanes, hydroairplanes, dirigibles, etc., designed and built to the individual requirements of your power plant and type of machine.

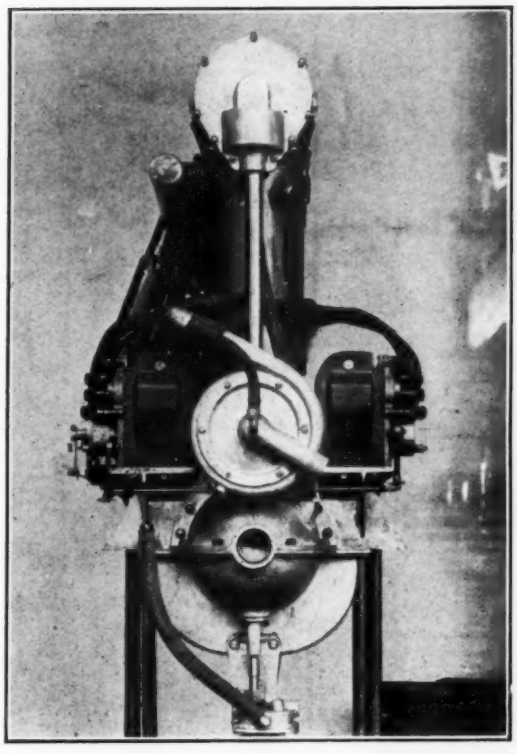
Inquiries solicited.

A high percentage of the latest and most successful war machines on the various fronts are equipped with LANG PROPELLERS.

Lang Propeller Company of America, Inc.

New York Office :: :: :: Room 419, 30 East 42d Street

UNION
120-H. P.
SIX



EXTRACTS FROM ARMY AND NAVY REPORT—

"The engine performed a very satisfactory endurance test. Observations throughout the test showed that the vibrations were low, quick acceleration and good carburetion maintained, also the absence of oil leakage was another good feature as well as no evidence of water leakage at any of the joints."

"The engine demonstrated that its design and construction was such that it would stand endurance test of a much longer duration as when the run was stopped the engine was functioning very satisfactorily."

"The inspection of the engine after the 48-hour endurance test showed the fundamental design to be such that satisfactory service would be given by this power plant. The quality of the workmanship throughout was of a very high order, and also that the very best of material had been used throughout the engine."

UNION GAS ENGINE CO.
OAKLAND—CALIFORNIA

METAL AIRPLANE FUSELAGES

AIRPLANE TUBING

Especially made to your own requirements

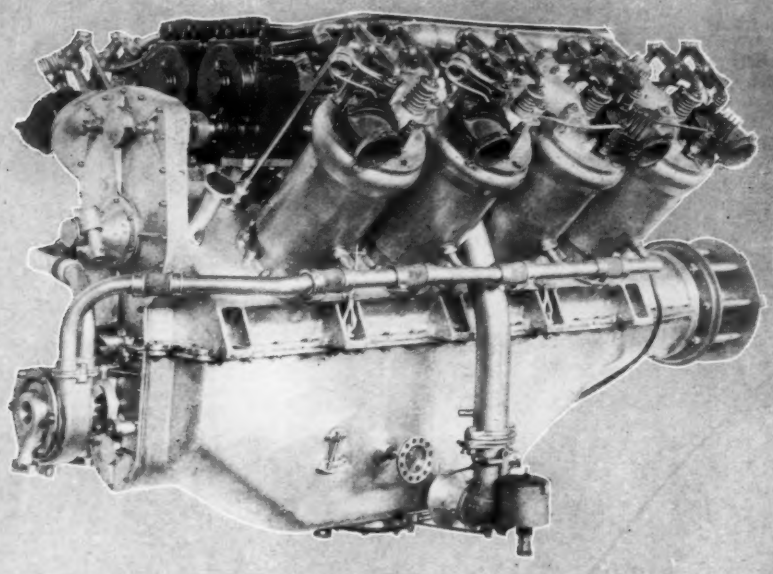
We are at present manufacturing for the larger airplane constructors our high grade tubing for almost *overnight deliveries.*

We are also manufacturing three distinct types of metal fuselages.

Special inquiries solicited.

The Empire Art Metal Co., Inc.

College Point, N. Y.



CURTISS

8 Cylinder 200 H. P. Airplane Engine

Magnalite pistons have been used exclusively on Curtiss VX Motors since the earliest period of that motor's production.

The fact that the Curtiss Aeroplane & Motor Corporation continues to equip VX Motors with Magnalite pistons exclusively is further evidence of Magnalite superiority.

Magnalite pistons are now used exclusively by sixteen of the largest and highest grade manufacturers of airplane, automobile and marine engines.

We have prepared a special booklet on piston design which will be gladly mailed upon request.

WALKER M. LEVETT COMPANY
417-419-421 East 23d Street New York

Magnalite Pistons

USA

WAR WILL END QUICK

When Aeroplanes of Speed and Durability are put into Service by the Allies

ALUMINUM SHEETS

Decrease Weight, Increase Speed, Strength and Durability

We carry the Largest Stock in the World—and Operate Our Own Rolling Mills

Service is Assured—Write us Today

WE ALSO MAKE ALUMINUM INGOTS, OF ALL GRADES—FOR CASTINGS OR STEEL PURPOSES—RODS—WIRES—GRANULES, ETC.

United Smelting & Aluminum Co., Inc.

NEW HAVEN, CONN.

BRANCHES:

24 Stone Street, New York City 1334 Dime Bank Bldg., Detroit, Mich. 959 Monadnock Bldg., Chicago, Ill.

Specialization

—in rubber parts for aircraft

WHAT is it you are experiencing difficulty in securing? Perhaps it is the rubber grips for your aircraft, or it may be good inner tubes. There are undoubtedly a hundred and one small and large parts that are retarding your deliveries. Bring your problems to us. Learn about

DURAL

rubber quality. Go where relieving you of the troubles you are now experiencing in securing rubber parts is a specialty. Familiarity with aircraft work, experienced men, and latest factory equipment enable us to quickly manufacture the various rubber parts you need.

You are anxious to increase your production! Are you being held back through inability to secure rubber parts? If so, tell us your requirements. Other firms like you are being helped by our service. We can do as much for you as we are doing for them. Write.

TRADE MARK DURAL RUBBER

TRADE MARK DURAL RUBBER

DURAL RUBBER CORPORATION
FLEMINGTON, N.J.

Aluminum Company of America

PITTSBURGH, PA.

Manufacturers of Aluminum

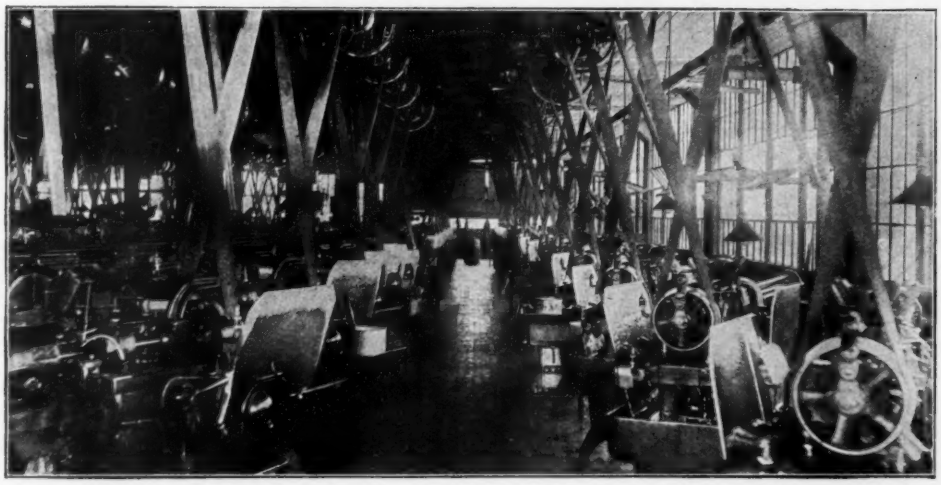
Ingot, Sheet, Tubing, Wire, Rod, Rivets, Moulding

General Sales Office, 2400 Oliver Building, Pittsburgh, Pa.

Branch Offices:

Boston . . . . . 131 State Street
Chicago . . . . . 1500 Westminster Building
Cleveland . . . . . 950 Leader-News Building
Detroit . . . . . 1512 Ford Building
Kansas City . . . . . 308 R. A. Long Building
Los Angeles *(Pierson, Roeding & Co., Agents)*
494 Pacific Electric Building
New York . . . . . 120 Broadway
Philadelphia . . . . . 1216-1218 Widener Building
Rochester . . . . . 1112 Granite Building
San Francisco *(Pierson, Roeding & Co., Agents)*
731 Rialto Building
Seattle *(Pierson, Roeding & Co., Agents)*
523 Colman Building
Washington . . . . . 509 Metropolitan Bank Building

Send inquiries regarding aluminum in any form to nearest Branch Office, or to General Sales Office



TURNBUCKLES

We Manufacture the Following Type Aeroplane Turnbuckles

Standard Type

No. 1 Female, Short A-1518	No. 2 Female, Long A-1520
No. 1 Male, Short A-1522	No. 3 Male, Long A-1524

Curtiss Type

326 Short, Male	327 Long, Female
326 Short, Female	327 Short, Female
326 Long, Female	328 Long, Female
327 Long, Male	329 Long, Female

The Dayton Metal Products Company

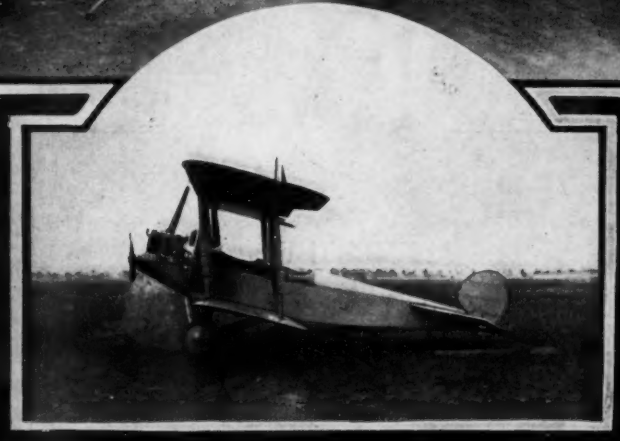
DAYTON, OHIO, U. S. A.

Aeromarine

The Aeromarine Plane and Motor Co. is now located at Keyport, New Jersey, in a factory designed especially for the manufacture of aircraft

ENGINEERING and SALES CO.

Manufacturers to Army and Navy. Member of Aircraft Manufacturer's Association, Inc. New York Office Times Building



"USCO" NUMBER 72

THE STANDARD KITE BALLOON FABRIC OF AMERICA

A TWO-PLY BIASED FABRIC, COATED BETWEEN PLIES WITH A LIGHT, TOUGH LAYER OF PURE PARA RUBBER.

THIS FABRIC HAS BEEN DEVELOPED FROM YEARS OF LABORATORY EXPERIENCE, AND POSSESSES EVERY FEATURE AND QUALIFICATION NECESSARY TO A WELL-BALANCED PRODUCT, VIZ.:

STRONG
GAS-TIGHT
NEUTRAL, INVISIBLE COLOR
WITHSTANDS ALL WEATHER CONDITIONS
AND AGES WELL

UNITED STATES RUBBER COMPANY AND ASSOCIATED COMPANIES — US — RUBBER SYSTEM

MADE BY THE
WORLD'S LARGEST RUBBER COMPANY

UNITED STATES RUBBER COMPANY
NEW YORK

"NORMA"

"NORMA" BALL BEARINGS

(Patented)

So small a thing as the bearings of the magneto or lighting generator may set the limit to the service capacity of an airplane. The failure of such a bearing, impairing the ignition or the lighting, may result in the condemnation of an otherwise high-class outfit.

The almost universal standardization of high-grade magnetos and lighting generators on "NORMA" Ball Bearings is proof of the confidence the makers of these accessories have in "NORMA" Quality as a safeguard to themselves and to the builders and owners of airplanes and engines.

Be SURE. See that your Electrical Accessories are "NORMA" Equipped

THE NORMA COMPANY OF AMERICA
1790 BROADWAY NEW YORK

Ball, Roller, Thrust and Combination Bearings.

"NORMA"

SEPTEMBER 15, 1917

AVIATION AND AERONAUTICAL ENGINEERING

VOL. III. NO. 4

Member of the Associated Business Papers, Inc.

INDEX TO CONTENTS

	Page
The 260-Horsepower Mercedes Aero-Engine	238
Vibrations of a Rotating Air-Screw and Its Shaft	242
Nieuport 1½ Plane Fighter	245
Completion of Liberty Engine	247
The Sylphon Motor Thermostat	248
Wire and Cable Standards Recommended by S. A. E.	249
The Boyce Motometer	250
Digest of the Foreign Aeronautical Press	251
News of the Fortnight	253

THE GARDNER, MOFFAT COMPANY, Inc., *Publishers*

120 WEST 32D STREET NEW YORK

WASHINGTON OFFICE, 308-10 EVENING STAR BUILDING

SUBSCRIPTION PRICE: TWO DOLLARS PER YEAR. SINGLE COPIES FIFTEEN CENTS. CANADA AND FOREIGN: TWO DOLLARS AND A HALF A YEAR. COPYRIGHT, 1917, BY THE GARDNER, MOFFAT COMPANY, INC.

ISSUED ON THE FIRST AND FIFTEENTH OF EACH MONTH FORMS CLOSE FIVE DAYS PREVIOUSLY. ENTERED AS SECOND-CLASS MATTER, AUGUST 3, 1916, AT THE POST OFFICE AT NEW YORK, N. Y., UNDER ACT OF MARCH 3, 1879.

The Creagh-Osborne Vertical Compass

A New Type of a Reliable Instrument for Army and Navy Airplanes

Radium-painted Figures Visible at Night

Liquid Damped

Generous Heeling Angle

THE SPERRY GYROSCOPE COMPANY Manhattan Bridge Plaza BROOKLYN, N. Y.

PARIS: 126 RUE DE PROVENCE

15 VICTORIA STREET, LONDON, S.W.

OUR facilities at Newport News, Va., permit us to take for aviation training immediately 40 more students, 30 on land machines 10 on flying boats.

This offers an excellent opportunity for men to gain aviation training at an old established school where the best of instruction and a wide variety of types of aeroplanes, hydroaeroplanes and flying boats are available.

Students will be accepted in order of enrollment.

For full information wire or apply

Atlantic Coast Aeronautical Station,
Newport News, Va.

Curtiss Curtiss

AVIATION
AND
AERONAUTICAL ENGINEERING

Vol. III September 15, 1917 No. 4

THE influence of war on a publication such as AVIATION AND AERONAUTICAL ENGINEERING is so overwhelming that a clear statement regarding the novel conditions brought about is, in all fairness, due to its readers. In order that they may understand the difficulties under which editorial matter of worth is secured, edited and censored, attention is directed to the following facts:

In the first place four officers of the company, namely the former President, Treasurer, Secretary and Military Editor are all in active military service. The President, Lester D. Gardner, is a Captain in the Aviation Section of the Signal Corps of the Regular Army; the Treasurer, William I. Seaman, is a member of the Veteran Corps of Artillery, which is on active duty guarding the water supply of New York; the Secretary, Joseph H. Coit, is a Captain in the Quartermaster's Corps, in charge of a transport for troops; the Military Editor, Philip J. Roosevelt, is a Captain in the Aviation Section of the Signal Corps of the Regular Army. The above named officers in Federal service have naturally resigned from the company and will have no connection with it for the duration of the war.

It is, however, very fortunate that the editorial staff which has directed the policy of AVIATION AND AERONAUTICAL ENGINEERING from the very beginning will continue its policies, so that, barring a few exceptions, there will be no noticeable changes.

The most important of these, however, will be the disappearance of the editorial page with the next issue. To be worthy of its readers' confidence, a policy of conservative and constructive criticism must underlie all editorial comment. With so many officers of the company in the services it would be extremely difficult to maintain an unbiased view of aeronautical progress.

Another reason which prompted the discontinuance of editorial comment is the strict censorship that is being exercised on all aeronautical information. Orders have been issued by the War Department to the effect that virtually all articles relating to engineering or construction must be submitted before publication. It may interest our readers to know that all articles and illustrations appearing in this magazine conform to the strict requirements of the censorship.

After the war, when, it is hoped, the officers who left the company to serve their country may return, it seems likely that the expression of editorial opinion will be resumed. But in these times, when all good citizens should be doing their utmost to secure for us and our Allies victory in the air, opinions not fully conversant with prohibited information would prove of no constructive value.

The Liberty Engine

The unanimous commendation greeting the appearance of the Liberty engine is well merited. Messrs. Hall and Vincent in particular deserve praise of the highest order for their achievement. Not only has a brilliant feat of engineering been brought to a satisfactory conclusion, but many phases pertaining to the design and construction of this engine were dramatic in the extreme. The story of how the Government's call for assistance was met by draftsmen as well as by manufacturers will have to wait for a time before it may see publicity, but there is no question that it represents a feat unequalled heretofore.

The Secretary of War's official statement recounting how the Liberty engine was conceived and executed furnishes most inspiring reading. Here we have the proof that, given the possibility of developing an engine under conditions paralleling those prevailing abroad, American engineers can design and build an aero engine equal to the best of those produced in Europe. What is more, this engine, which was produced in less time than it would have taken to bring a European model over here, is particularly suited for American manufacturing conditions.

There is, however, behind this marvel of American ingenuity a certain ancestral influence which the popular accounts appearing in the daily press have failed to emphasize. The manufacturers of American aero engines, who have, in the past, made considerable investments amid little official encouragement in order to develop a satisfactory aero engine of national make, share in no mean way the responsibility for the success of the new engine.

They have placed not only their experience and their designs at the disposal of the Government, permitting the latter to embody in the Liberty engine such features as represent the best present-day practice, but they have also loaned their engineers to the Government so that their experience might result in a permanent achievement. It is this admirable voluntary cooperation between the aircraft industry and the Government which has chiefly been instrumental in making a success of the Liberty engine, and it is to be hoped that the intimate understanding thus established between the two parties concerned will have created a happy and fruitful precedent, which should largely influence the carrying out of America's air program.

The 260 Horsepower Mercedes Aero-Engine*

The 260 hp. Mercedes aero-engine herewith described is typical of German ideas at the moment, and resembles in general design and even in minor details the well known 150 and 175 hp. models of the same manufacturers.

The complete engine, including the propeller boss, measures 6 ft. 5½ in. over all, and from the bottom of the sump to the top of the overhead camshaft casing measures approximately 3 ft. 10 in. The bore of the cylinders is 160 mm. (6.2992 in.) and the stroke 180 mm. (7.0866 in.). The engine is of the vertical, water-cooled type with six independent steel cylinders, each cylinder carrying in the head two inlet and two exhaust valves which are operated by an overhead camshaft running in a separate housing. The valves are interchangeable. The well-known four-throw eccentric driven plunger pump and the half-compression gear of the 160 hp. model have been retained with slight alterations. Forced lubrication is employed. Two Bosch Z.H.-6 high tension magnetos are fitted.

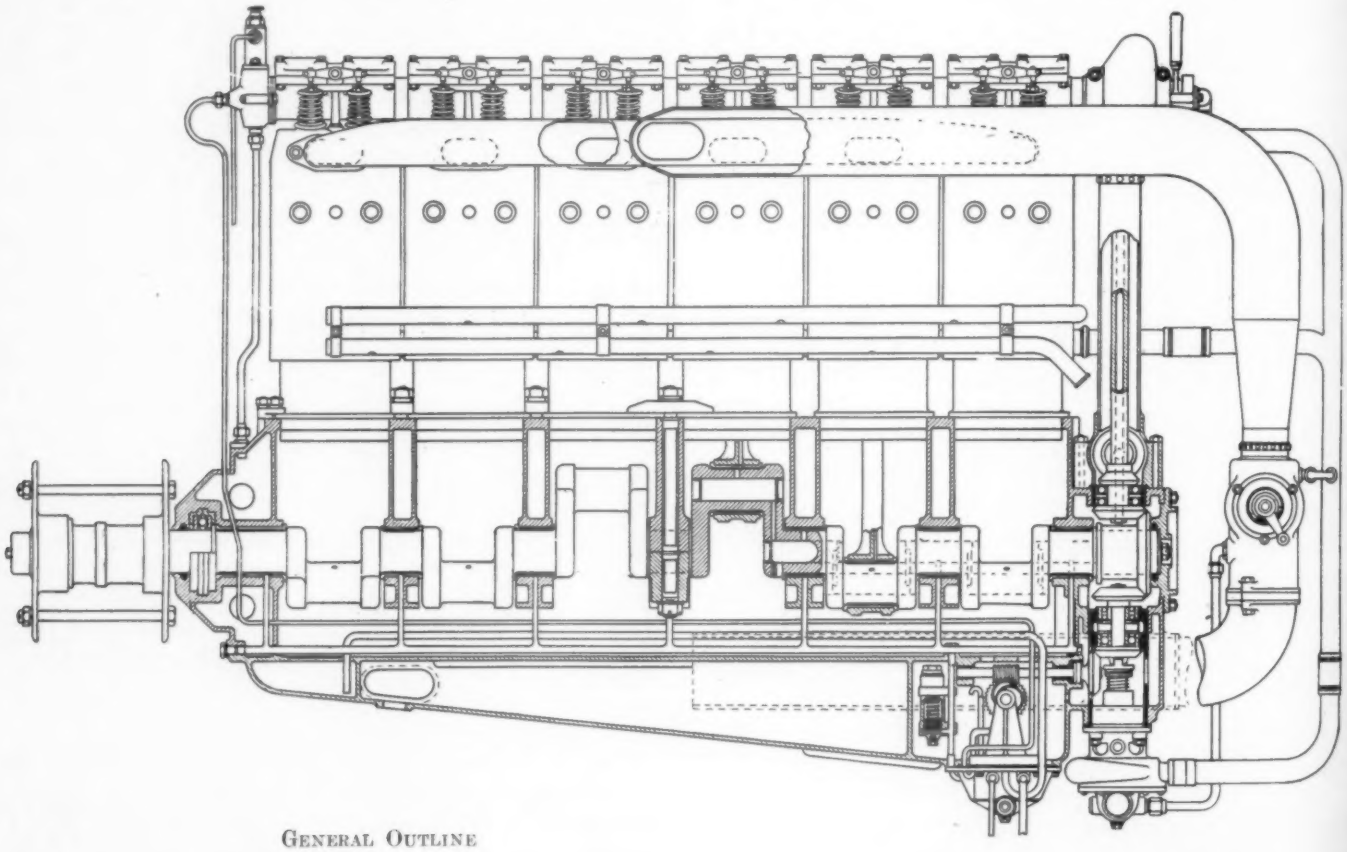
Cylinders.—The cylinders are built up entirely of steel machined all over, with autogenously welded steel sheet water jackets. The cylinder barrels are screwed into the cylinder head and are machined from forgings or billets. The cylinder walls taper in section from 3.5 mm. at the top to 6 mm. at the base flange. Six stiffening ribs are machined on the cylinder, the distance between the ribs increasing towards the base. The barrels extend 35 mm. below the base flanges and are of 3 mm. thickness for the depth of 12 mm., forming the register, the extension being then reduced to 2.75 mm.

The cylinder heads are steel forgings, the thickness of the crown being 11 mm. The valve seats are machined in the cylinder heads, while the valve pockets are machined from steel forgings autogenously welded to the cylinder heads.

The water jackets are built up in four sections from sheet steel pressings of 1.25 mm. thickness, their lower portion being welded to the flange joint on the cylinder walls. The upper portion surrounds the valve pockets. The spark plug bosses are welded into the cylinder barrels on the induction side, just below the inlet valves. The complete cylinder, with valves and valve springs, and including the two brackets supporting the camshaft housing, weighs 34.25 lb.

Pistons.—The pistons are built up in two halves. A steel forging machined all over forms the head, the thickness of the crown being 8.5 mm. The skirt of the piston is made of cast iron and is screwed on to the head, the joints being autogenously welded. Three compression rings are fitted; these are 5 mm. wide and split at 45 deg. The gudgeon pin is 37 mm. in diameter and is fixed by an 8 mm. set screw. The weight of the piston, complete with pin and bush, is 11 lb.

Valves.—The maximum diameter of the head of all valves is 60 mm., while the port diameter is 55.25 mm. The lift of both inlet and exhaust valves is 10 mm.



General Outline

The valves are operated by a single overhead camshaft, enclosed in a housing of special alloy which is supported on T brackets screwed into the cylinder heads.

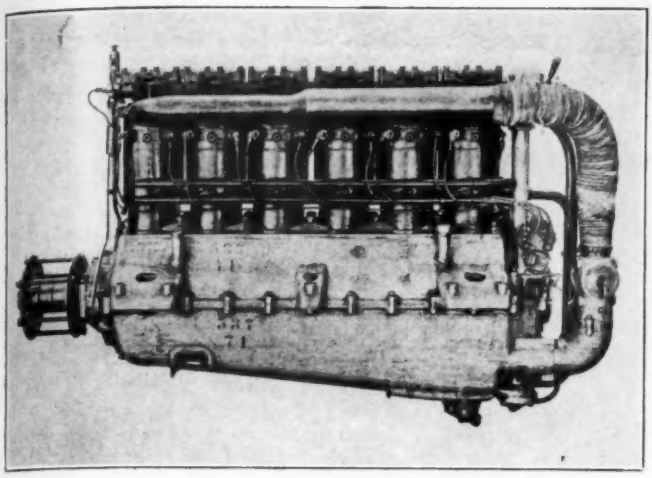
The diameter of the valve stems is 11 mm. All valves are set at an angle of 15 deg. to the cylinder center line. Single helical valve springs are fitted. They measure 39 mm. at the base of the coil, and taper to 31 mm. at the top.

Camshaft Drive.—The camshaft is driven through a vertical shaft by the main distribution bevel pinion mounted on the end of the crankshaft.

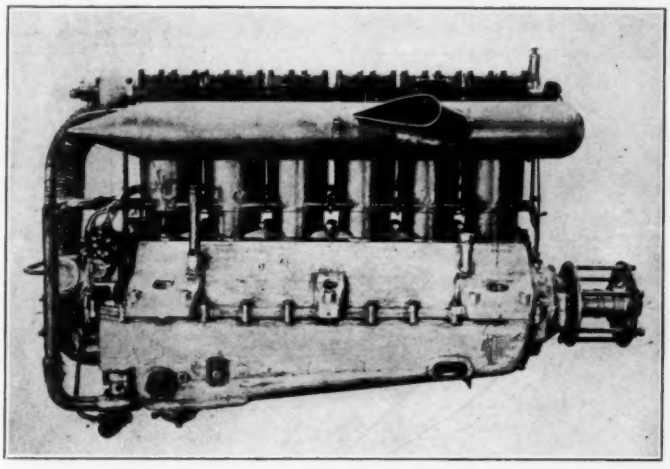
Decompression Gear.—To effect half compression the camshaft is designed to slide longitudinally in its bearings and bring into operation a small cam situated on the mid-neutral axis of the exhaust cam proper. The camshaft is made to slide by a hand lever to which is attached a collar located in an aluminum housing at the driving end of the camshaft. This collar engages with a screw thread cut on the outer diameter of a steel sleeve containing a double ball thrust. In operation the rotation of the hand lever acts on the quick thread screw in the sleeve, thus displacing the end of the camshaft in its bearings through castellations fitted to the driving bevel gear. When drawn to its rear limit, the decompression cam is engaged with the roller end of the exhaust valve rocker arm, giving the required lift to the exhaust valves.

Connecting Rods.—These are steel forgings of H-section

* Abstract from *The Automobile Engineer* (London).



INDUCTION SIDE



EXHAUST SIDE

and measure 326 mm. between centers. The total weight is 7 lb. The distinctive feature of the connecting rods is the floating gudgeon pin bush, which is of hardened steel, and is running fit in the small end and also on the gudgeon pin. It is pierced by fourteen 5 mm. holes, to which oil is supplied by a 6 mm. pipe leading from the big end bearing.

Crankshaft.—The crankshaft is of the six-throw type, running on plain bearings, and weighs 139.5 lb., including the propeller boss.

The crankshaft is hollowed out and provided with webs for passage of the lubricating oil. A ball thrust washer of 110 mm. diameter is provided on the front bearing to take the propeller thrust. The propeller boss is mounted on a taper on the crankshaft; the propeller is secured to the boss by six 18 mm. bolts.

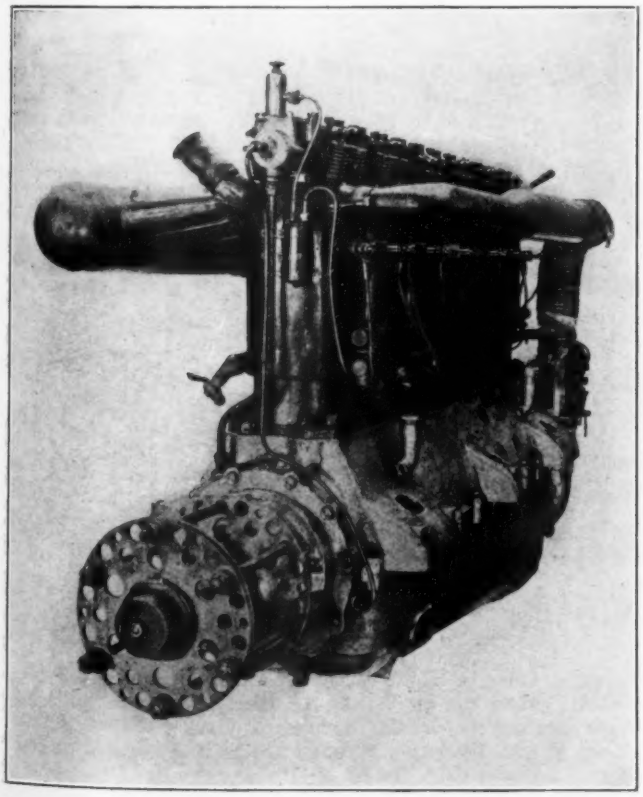
Crankcase.—The crankcase is of conventional design, the top and bottom halves being held together by twenty-six 10 mm. hollow bolts. The crankshaft main bearing caps are cast with the bottom half, and the long 20 mm. bolts, securing them at the bottom, pass through the top half and act as holders for the cylinders.

The main oil sump is located in the rear end of the crank chamber and contains the main oil pump; in the front end there is an auxiliary sump in which the return oil is drained by means of a wire gauze filter. Between the two sumps an air chamber is provided for the purpose of cooling the oil and warming the air supplied to the carburetor.

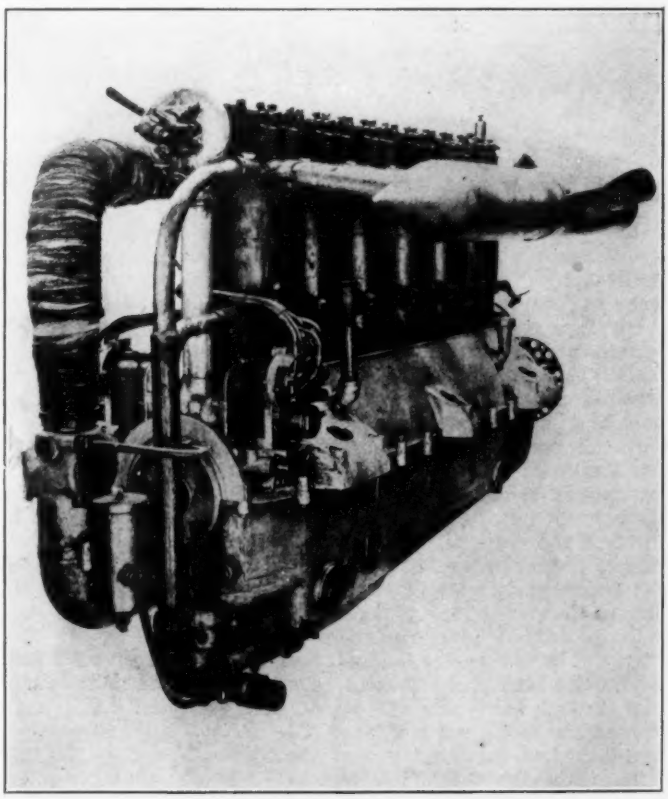
Lubrication.—Forced lubrication is employed. This is effected by means of two main plungers; three auxiliary plungers are suspended from one of the main plungers, and these work in conjunction with piston valve plungers at the sides of the main pump. Each pump and plunger is operated by an eccentric driven by a worm gear from a layshaft at a 17 to 1 ratio to engine speed. The layshaft is driven by bevel gearing from the vertical driving shaft of the water pump, the latter being actuated from the main bevel gear at the rear of the crankshaft.

The lubrication system may be subdivided into three circuits, namely:

(*a*) The main pressure circuit, in which oil is drawn from the main oil sump at the rear of the engine and forced to the crankshaft, connecting rods, camshaft bearings, etc.

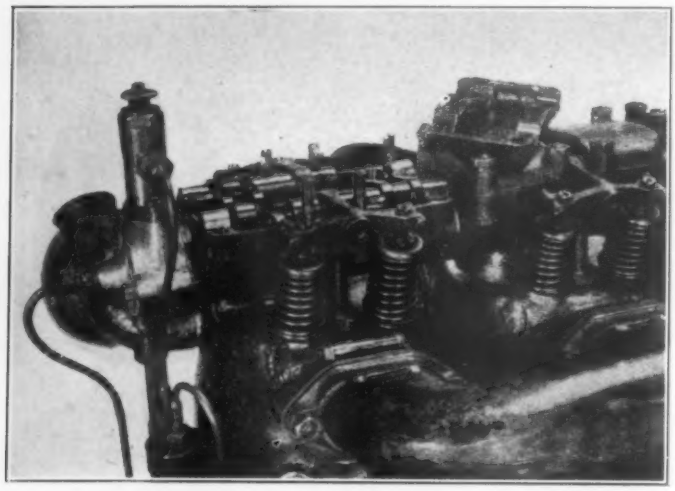


PROPELLER END



ANTI-PROPELLER END

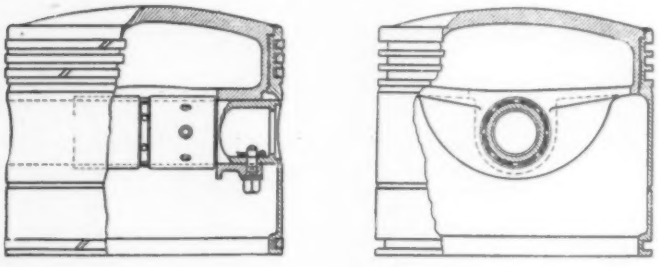
(*b*) The supplementary pressure system that works in conjunction with the main high pressure system, in which two auxiliary plungers of the main oil pump draw a small charge of fresh oil from the service oil tank at every stroke, and thus



Valves and Camshaft

keep the main circulation supplied with a certain quantity of fresh oil.

(*c*) A suction scavenging circuit, which supplies the main oil sump from the auxiliary drain sump at the front of the base chamber, the working oil level being maintained in the



The Piston

rear sump by a secondary suction pump that draws off the oil above the oil level through an overflow pipe and returns it to the service oil tank.

In the main pressure system the functioning of the oil pump is the following: Oil is drawn from the main sump through a wire gauze filter by the suction of the main plunger pump *A* through the port *B* in conjunction with the piston valve *C*, when the latter is in the open position with the port *B*.

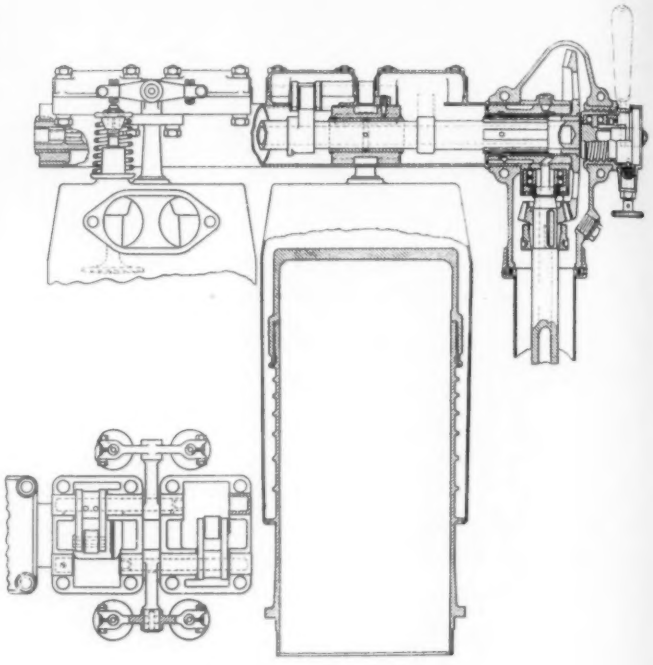
On the downward stroke of the main plunger *A*, the oil is forced through the port *B* and the annular space above the piston valve *C*, through the main delivery pipe *D*, to the main bearings, when the piston valve *C* has uncovered the port *B* on its downward stroke.

Simultaneously the auxiliary plunger *E*, which is fitted to the bottom of the plunger *A*, draws a charge of fresh oil on its upward stroke. This charge is taken through a port in the bottom end of the valve plunger from the oil service tank through the pipe *G*, and on the downward stroke of the plunge pump *E*; the charge of oil is forced upward through the hollow valve plunger through the port *H*, and through a hole in the stem of the plunger, which communicates with the main oil delivery pipe *D* to the main bearings.

At the same time the twin plunger E_1 draws fresh oil from the service tank and forces the charge to the camshaft bearings through the pipe *J*, the oil entering the front end of the camshaft through the hollow spindle of the air-pump, which is attached to the front end of the camshaft casing. In its passage through the hollow camshaft the oil under pressure is fed through small holes and oil grooves cut in each of the camshaft bearings.

The camshaft rocker arm spindles are lubricated by oil thrown off the revolving cams, which deliver oil into two holes drilled in the upper portion of the rocker arm spindles. These holes communicate with the bearings by small holes drilled radially in the spindle.

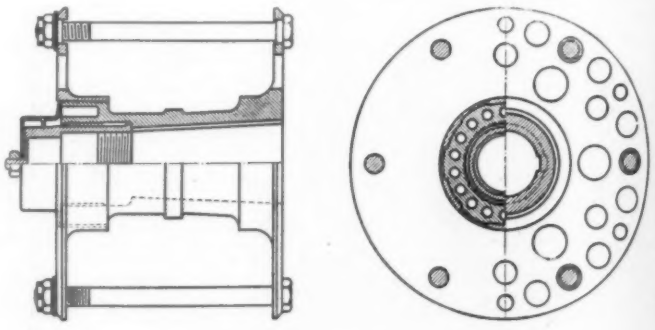
No outlet holes are provided in the rear end of the camshaft for the egress of the oil; consequently, the camshaft is under constant oil pressure, which finds its way through the bearings into the troughs in the bottom of the camshaft housing. The overflow oil returns to the crankcase through the air pump, escaping therefrom at the bottom by a 12 mm. pipe running down to the front end of the engine. At the rear end of the camshaft casing oil escapes down the hollow, vertical shaft, oil channels being cut in the underside of each of the camshaft bearing bushes for the purpose.



Decompression Gear

The oil that has thus returned by gravity to the crankcase is led into the oil sump at the rear through two holes of 30 mm. diameter, drilled in the false bottom of the base. At the forward end of the crankchamber, the oil flows into the auxiliary sump through a wire gauze filter already referred to.

From the auxiliary sump the oil is drawn by the scavenger pump *K* through the port *L* (cut in the bottom of the barrel),

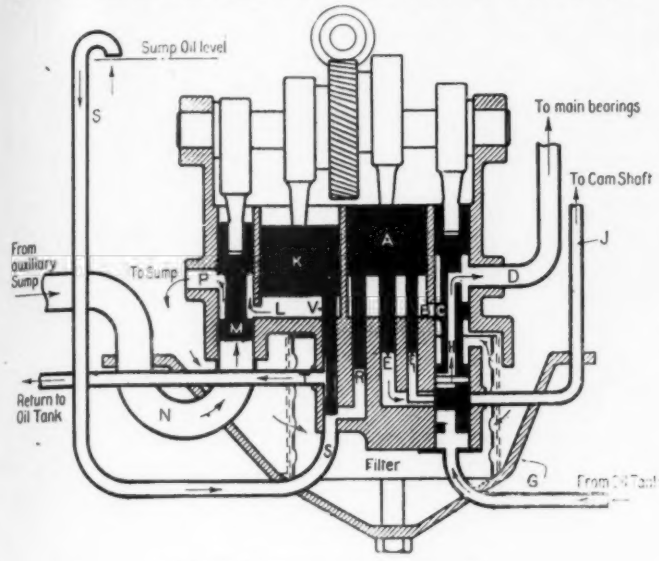


Propeller Boss

the piston valve *M* being in its upward position. The oil, therefore, enters the pump through the large suction pipe *N*, and is discharged on the downward stroke of the pump plunger *K* into the sump through the port *P*, drilled in the side of the piston valve barrel.

To maintain the correct working oil level in the sump, a third plunger *R*, also attached to the bottom of the main plunger pump *A*, draws off, through the suction pipe *S*, any

surplus oil above the working level in the sump, and returns it to the oil service tank through the pipe *T*. On the down-



Cross-Section of Oil Pump

ward stroke of the plunger *R*, the latter works in conjunction with the piston valve *V*, which is flexibly attached to the bottom of the suction pump *K*, in a slot cut in the face of the pump. In the main pressure delivery pipe to the crankshaft bearings, and directly above the oil pump, a pulsation damper valve is located.

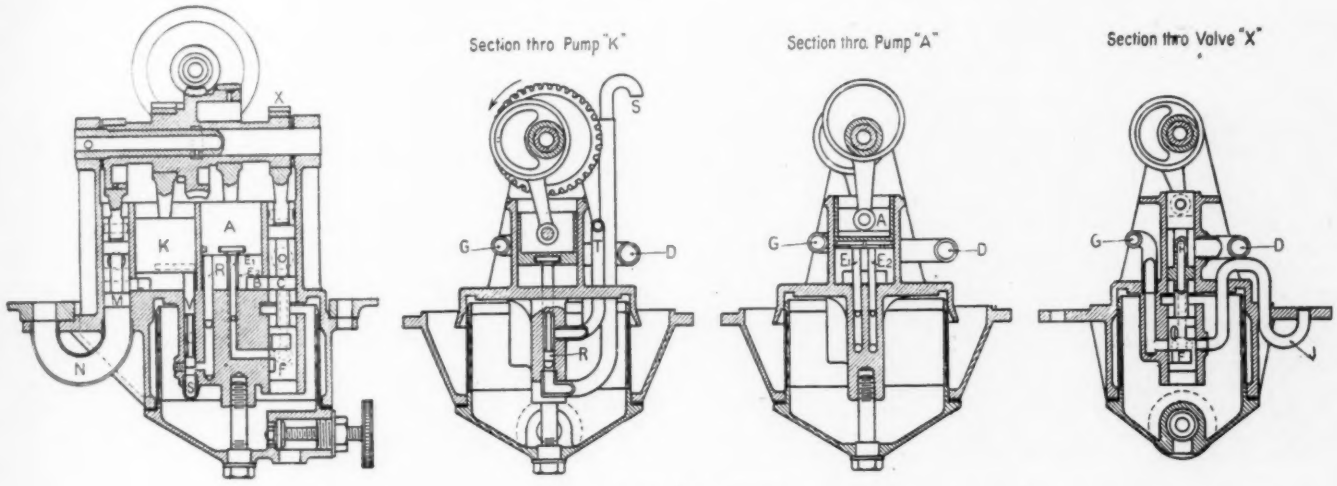
In operation, the pulsations of the oil pump plungers are damped out in the delivery pipe by the cushioning effect of the spring-loaded plunger, which communicates direct with the pump on its underside. The bottom face of the plunger is prevented from reaching the bottom of the barrel by a small set-screw in the base.

The lubrication of the crankshaft and connecting-rod bearings is on standard lines; details of this are shown in the general outline of the engine.

Induction.—Induction is effected by one carburetor only, which is situated at the after end of the crankshaft. The float chamber of the carburetor is fitted on the bottom with a filter chamber, the gasoline being led through a wire gauze filter.

Ignition.—Ignition is effected by two Bosch high-tensioned magnetos, which are mounted at the rear end of the crankcase, one being a starter magneto used in conjunction with a hand starter dynamo. All twelve spark plugs are fitted below the inlet valves, the high-tension wire being carried in fiber tubes.

Water Pump.—The water pump is of the centrifugal type and is driven by a vertical shaft through a bevel gear on the end of the crankshaft. The pump is mounted on a flange on the bottom of the sump, next to the oil pump. Double inlet water connections between each of the six cylinders supply the water jackets at the top and bottom.



Details of Oil Pump

Aeronautical Patents

ISSUED AUGUST 14, 1917

1,236,493. To Howard J. Smiley, Canton, Ohio. Launching and Landing Device.
1,236,603. To John J. Reynolds and Arthur H. Jenkins, Ruleville, Miss. Dirigible-Balloon Construction.
1,236,961. To Thomas Rutherford MacMechen and Walter V. Kamp, New York, N. Y. Airship.
1,236,741. To Harrison R. Morris, Mapleton, Kans. Flying Machine.
1,237,039. To Willoughby A. Heuley, Altus, Okla. Airplane.
1,237,072. To William H. McMullen, Whitestone, N. Y. Steering or Stabilizing Device for Airplanes.
1,237,266. To Lewis Nixon, New York, N. Y. Incendiary Attachment for Airplanes.

ISSUED AUGUST 21, 1917

1,237,318. Filed Oct. 10, 1916. To John Flink, Philadelphia, Pa. Airship.
1,237,364. Filed June 10, 1914. To Henry Miller, Cicero, Ill. Flying Machine.
1,237,715. Filed May 29, 1916. To James F. Smith, Los Angeles, Cal. Adjustable Water-Planing Surface.
1,237,734. Filed May 17, 1915. To Rushmore Wood. Standard of Position for Aircraft.
1,237,772. Filed Mar. 16, 1917. To Robert E. Friederick, Rogers, Mich. Flying Machine.
1,237,789. Filed Aug. 5, 1912. To William H. Kelly, Cheyenne, Wyo. Flying Machine.
1,237,888. Filed Oct. 14, 1916. To Alphonse Fernandez, Washington, D. C. Airship.
1,237,889. Filed Oct. 14, 1916. To Alphonse Fernandez, Washington, D. C. Airship-Engine Release.
1,237,890. Filed Oct. 14, 1916. To Alphonse Fernandez, Washington, D. C. Bomb-Dropping Mechanism.
1,238,031. Filed Mar. 28, 1912. To Ladis Lewkowicz, New York, N. Y. Aeronautical Apparatus.

ISSUED AUGUST 28, 1917

1,234,264. Filed July 27, 1916. To Jan Chodakowski, Binghamton, N. Y.
1,234,315. Filed Sept. 25, 1916. To Thomas Rutherford Macmechen and Walter V. Kamp, New York, N. Y. Airship.
1,234,316. Filed Oct. 7, 1916. To Thomas Rutherford Macmechen and Walter V. Kamp, New York, N. Y. Airship.
1,234,451. Filed Jan. 4, 1917. To Ernest L. Sons, Pittsburgh, Pa., assignor of one-half to S. A. Boyd, Pittsburgh, Pa. Airship.
1,234,572. Filed Sept. 27, 1916. To Elmer L. Russell, Great Falls, Mont. Aeroplane.

ISSUED SEPTEMBER 4, 1917

1,239,041. Filed Sept. 19, 1916. To Verdon Roe, Manchester, Eng. Belt Support for Aviators.
1,239,907. Filed Mar. 25, 1915. To Charles E. Gordon, Marlborough, Mass. Aerohydro-ship.
1,239,904. Filed Apr. 5, 1917. To William F. Folmer, Rochester, N. Y., assigned to Eastman Kodak Co., Rochester, N. Y. Aerial Carrier for Photographic Films.
1,238,839. Filed Nov. 25, 1916. To Thomas B. Slate, Washington, D. C., assignor to American Mechanical Improvement Co., Washington, D. C. Aero-Vehicle Body

Vibrations of a Rotating Air-Screw and Its Shaft*

By A. Fage, A.R.C.Sc.

The present paper gives the mathematical theory of the transverse vibrations of a rotating air-screw and its shaft, and also an application of the method to several practical problems. For generality, the calculations have been made for a two-bladed air-screw when the transverse vibrations are in a plane parallel to both the axis of the air-screw blades and the axis of rotation, and also when in a plane at right angles to the axis of the air-screw blades and parallel to the axis of rotation. The dependence of the frequency of the transverse vibrations on the length of the shaft, and also on the speed of rotation, has also been determined. Finally, by the elimination of quantities which only slightly influence the value of the frequency of the transverse vibrations, a moderately accurate working formula has been evolved, from which the whirling speed of a rotating air-screw and shaft may be readily calculated. The whirling speed of a modern air-screw as now mounted on the engine of an airplane is very high and very much greater than the bursting speed of the air-screw. The mathematical theory of the transverse vibrations of rotating systems is given by Dr. Chree in the Proceedings of the Physical Society of London (1903-5).

In order that the present paper may be complete it is desirable at the outset to indicate the relationship between the frequency of the lateral transverse vibrations and the whirling speed. Taking the simple case of a shaft of negligible mass, fixed at one end and carry a mass M at the other, it can easily be shown, if $\frac{p}{2\pi}$ be the frequency of the transverse vibrations of the mass M when the shaft is not rotating, and $\frac{q}{2\pi}$ the frequency of the transverse vibrations when the shaft is rotating with an angular velocity ω, that $q^2 = p^2 - \omega^2$.

The elastic forces of the shaft tend to restore the mass to its equilibrium position, but the centrifugal force acting on the mass has the opposite tendency, and by reducing the magnitude of the righting force diminishes also the frequency of vibration of the rotating mass and shaft. If ω be equal to p, the frequency of the transverse vibrations is zero, so that the mass is in neutral equilibrium no matter what the value of the lateral displacement may be, and hence if the lateral displacement be sufficiently great the shaft will fracture. A shaft in such a state is said "to whirl," the righting force due to the elasticity of the system having been reduced to zero by the centrifugal force called into being by deflection. For this particular instance the frequency of rotation when the shaft is whirling, and the frequency of the transverse vibrations when the shaft it not rotating, have equal values, but this is not the case with a rotating air-screw and shaft in which moments of inertia and damping need consideration.

To Find the Frequency of the Transverse Vibrations of Rotating Air-Screw and Shaft

The following investigation is an application of Lagrange's equations for small oscillations.

An instantaneous position of the rotating and vibrating air-screw and shaft is shown in Fig. 1, the plane of vibration of the shaft being coincident with the plane of the paper. It is assumed that the air-screw shaft is fixed in direction at the end O, so that the line OX represents the mean position of the vibrating shaft, and also the axis about which the rotation is taking place.

The following symbols are used in the investigation:

- L = Length of the shaft in feet.
- M = Mass of the air-screw in slugs.
- m = Mass of the shaft in slugs per ft. run.
- I_1 = Moment of inertia of the air-screw about the axis CA in slug-ft.^{2}.
- I_2 = Moment of inertia of the air-screw about an axis through C at right angles to the plane of bending.
- I_3 = Moment of inertia of the air-screw about an axis through C in the plane of bending and at right angles to CA.
- ω = Speed of rotation of the air-screw in radians per second.
- E = Young's modulus of elasticity in pounds per square foot.
- I = Moment of inertia of a cross-section of the shaft about a diameter measured in ft.^{4}.
- x = Distance from O, in feet, of any point P on the axis of the shaft.
- y = Deflection, in feet, of the point P from the line O X.

At any time t the free end of the shaft is displaced a distance z from its mean position, and the plane of the air-screw has an angular displacement θ from its mean position.

The equations of motion are expressed in terms of the variables θ and z.

From the above remarks it follows that when

$$x = 0, \frac{dy}{dx} = 0 \text{ and } y = 0,$$

when

$$x = L, \frac{dy}{dx} = \theta \text{ and } y = z.$$

So that the equation of the curve of the center line of the shaft is

$$y = \left(\frac{3z - \theta L}{L^2}\right) x^2 + \left(\frac{\theta L - 2z}{L^3}\right) x^3.$$

Lagrange's equations for a damped vibrating system in which there are two variables, θ and z, are

$$\frac{\delta}{\delta t}\left(\frac{\delta T}{\delta \dot{\theta}}\right) - \frac{\delta T}{\delta \theta} + \frac{\delta V}{\delta \theta} + \frac{\delta F}{\delta \dot{\theta}} = 0$$

and

$$\frac{\delta}{\delta t}\left(\frac{\delta T}{\delta \dot{z}}\right) - \frac{\delta T}{\delta z} + \frac{\delta V}{\delta z} + \frac{\delta F}{\delta \dot{z}} = 0$$

where T = kinetic energy of the whole system,
V = potential energy of the whole system,
and F = half the rate at which energy is being dissipated.

For the case of a vibrating air-screw and shaft the kinetic

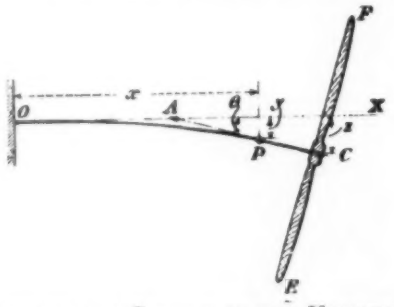


Fig. 1. Diagrammatic Sketch of the Vibrating Airscrew Plane of Vibration Coincident with Plane of Paper EF-Axis of Airscrew Blades

energy of the whole system is equal to the kinetic energy of the shaft + the kinetic energy of the air-screw.

$$= \int_0^L \frac{I}{2} m\, dx \left[\dot{y}^2 + (y\omega)^2\right] + \frac{M}{2}\left(\dot{z}^2 + \omega^2 z^2\right) + \frac{I_1}{2}\omega^2 \cos^2\theta + \frac{I_3}{2}\omega^2 \sin^2\theta + \frac{I_2}{2}\dot{\theta}^2.$$

$$= \left\{ \begin{array}{l} \dfrac{m\omega^2 L}{2}\left[\dfrac{1}{5}(3z - \theta L)^2 + \dfrac{1}{3}(3z - \theta L)(\theta L - 2z) + \dfrac{1}{7}(\theta L - 2z)^2\right] \\ + \dfrac{mL}{2}\left[\dfrac{1}{5}(3\dot{z} - \dot{\theta} L)^2 + \dfrac{1}{3}(3\dot{z} - \dot{\theta} L)(\dot{\theta} L - 2\dot{z}) + \dfrac{1}{7}(\dot{\theta} L - 2\dot{z})^2\right] \\ + \dfrac{M}{2}(\dot{z}^2 + \omega^2 z^2) + \dfrac{I_1\omega^2}{2} + \dfrac{I_2}{2}(\dot{\theta}^2 - \omega^2\theta^2) \end{array} \right\}$$

since $I_1 = I_2 + I_3$ and $\sin\theta = \theta$ nearly.

The potential energy, V, of the system is equal to the potential energy of the shaft =

$$\int_0^L \frac{EI}{2}\left(\frac{d^2y}{dx^2}\right)^2 dx.$$

$$= \int_0^L \frac{EI}{2}\left[\frac{2}{L^2}(3z - \theta L) + \frac{6x}{L^3}(\theta L - 2z)\right]^2 dx$$

$$= \frac{2EI}{L^3}\left[3z^2 - 3z\,\theta L + \theta^2 L^2\right]$$

Owing to the vibratory motion of the air-screw blades through the air, energy is dissipated, the rate of such dissipation—$2F$—being equal to $K\dot{\theta}^2$, where K is a constant. The value of the damping factor K can be readily calculated when the aerodynamical data of the blade sections of the air-screw and also the working conditions of the air-screw are known, but it may be of some interest to explain in general language why the rate at which energy is dissipated is proportional to the square of the angular speed of vibration.

Consider the vibratory motion of the blades about an axis through C (Fig. 1) at right angles to the axes of the air-screw and of the air-screw blades, the air-screw having the forward translational speed of the airplane, and a rotational speed

* From *Engineering* (London).

about the axis $O\ X$ of ω radians per second. For any positive value of the angular velocity $\dot{\theta}$, the thrust on the blade $C\ F$, which is moving into the air with a velocity greater than that due to the motion of the airplane alone, is diminished, while the thrust on the blade $C\ E$ is increased, the change of thrust of an aerofoil section of the blade being roughly proportional to the change of angle of incidence of the section relatively to the air. As a first approximation the change of the angle of incidence of a blade section is proportional to $\dot{\theta}$, so that the change of thrust of the blade and therefore also the damping moment on the air-screw is proportional to $\dot{\theta}$. Writing the damping moment as $K\dot{\theta}$ the rate at which energy is dissipated becomes $K\dot{\theta}^2$. It will be shown later that the damping moment does not appreciably influence the frequency of the transverse vibrations. Hence

$$F = \frac{K\dot{\theta}^2}{2}$$

where K is a constant.

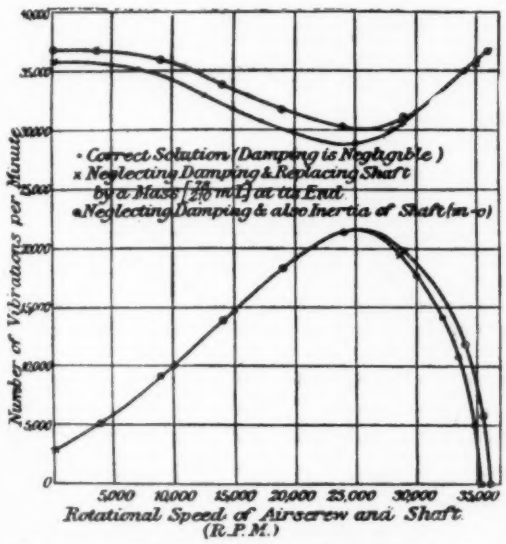


FIG. 2. TRANSVERSE VIBRATION IN A PLANE PARALLEL TO THE AXIS OF ROTATION & TO THE BLADE-AXIS. L-0-5 FT. L-3-5 SLUG-(FT.)$_2$

Substituting the above values of T, V and F in the Lagrangean equations we get:

$$I_2\ddot{\theta} + \frac{m\,L^2}{210}\left(2\,L\,\ddot{\theta} - 11\ddot{z}\right) - \frac{m\,\omega^2\,L^2}{210}\left(2\,L\,\theta - 11\,z\right) + I_2\omega^2\,\theta + \frac{2\,E\,I}{L^3}\left(2\,\theta\,L^2 - 3\,z\,L\right) + K\,\dot{\theta} = 0$$

and

$$M\ddot{z} + \frac{m\,L}{210}\left(78\ddot{z} - 11\,L\,\dot{\theta}\right) - \frac{m\,w^2\,L}{210}\left(78\,z - 11\,L\,\theta\right) + M\,z\,\omega^2 + \frac{2\,E\,I}{L^3}\left(6\,z - 3\,\theta\,L\right) = 0$$

Which when collected in a convenient form, become

$$\left[\left(I_2 + \frac{2}{210}m\,L^3\right)D^2 + K\,D + \left(I_2\omega^2 - \frac{2}{210}m\,\omega^2\,L^3 + \frac{4\,E\,I}{L}\right)\right]\theta - \left[\frac{11}{210}m\,L^3\,D^2 + \left(\frac{6}{L^2}E\,I - \frac{11}{210}m\,\omega^2\,L^3\right)\right]z = 0$$

and

$$-\left[\frac{11}{210}m\,L^3\,D^2 + \left(\frac{6\,E\,I}{L^2} - \frac{11}{210}W\,\omega^2\,L^2\right)\right]\theta + \left[\left(M + \frac{78}{210}m\,L\right)D^2 + \left(\frac{12\,EI}{L^3} - M\,\omega^2 - \frac{78}{210}m\,\omega^2\,L\right)\right]z = 0$$

So that the complete motion is given by the solution of the differential equation:

$$\left.\begin{aligned}&\left[\left(I_2 + \frac{2}{210}m\,L^3\right)D^2 + K\,D + \left(I_2\,\omega^2 - \frac{2}{210}m\,\omega^2\,L^3 + \frac{4\,EI}{L}\right)\right]\\ &\left[\left(M + \frac{78}{210}m\,L\right)D^2 + \left(\frac{12\,E\,I}{L^3} - M\,\omega^2 - \frac{78}{210}m\,\omega^2\,L\right)\right]\\ &\quad - \left[\frac{11}{210}m\,L^3\,D^2 + \left(\frac{6\,E\,I}{L^2} - \frac{11}{210}m\,\omega^2\,L^3\right)\right]^2\end{aligned}\right\}\theta = 0$$

Owing to the large number of algebraic terms—several of them having neglible values—no advantage is to be gained by attempting to solve the differential equation of the fourth order in its present form. By the substitution of the numerical values of the symbols the equation may be written in the form

$$(D^4 + A_1\,D^3 + A_2\,D^2 + A^3\,D + A_4)\,\theta = 0$$

where A_1, A_2, A_3, A_4 are numerical constants. For all practical purposes the values of A_1 and A_3 are each equal to zero, so that the equation is reduced to $(D^4 + A_2\,D^2 + A_4)\,\theta = 0$.

The air-screw and shaft commence to whirl when the frequency of one of the transverse vibrations just becomes zero, so that at the whirling speed the solution of the equation

$$(D^4 + A_2\,D^2 + A_4)\,\theta = 0$$

becomes

$$\theta = B_1 + B_2\,t + B_3\sin\beta\,t + B_4\cos\beta\,b$$

where B_1, B_2, B_3 and B_4 are arbitrary constants depending on the initial conditions. For a rotational speed less than the whirling speed the motion consists of two vibrations, while at a rotational speed greater than the whirling speed the motion is compounded of a vibration, a divergence and a subsider, so that if the divergence is allowed to persist the shaft fractures.

APPLICATION OF THE PRECEDING THEORY TO SEVERAL PRACTICAL PROBLEMS

With the object of simplifying the differential equation of the motion of the vibrating air-screw and shaft a systematic series of calculations has been made to ascertain how the frequency of the vibrations depends upon the damping, the mass and the length of the shaft, the mass and the moment of inertia of the air-screw.

The following data, which are needed in the calculations, have been taken from a modern two-bladed air-screw, which, rotating at about 1300 r.p.m., would give a machine weighing

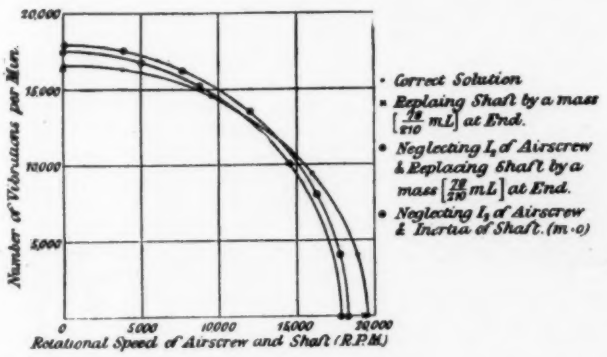

• Correct Solution
• Replacing Shaft by a mass [78/210 mL] at End.
• Neglecting I_2 of Airscrew & Replacing Shaft by a mass [78/210 mL] at End.
• Neglecting I_2 of Airscrew & Inertia of Shaft. (m=0)
Number of Vibrations per Min.
Rotational Speed of Airscrew and Shaft (R.P.M.)
0
5,000
10,000
15,000
20,000

FIG. 3. TRANSVERSE VIBRATIONS IN A PLANE PARALLEL TO THE AXIS OF ROTATION AND AT RIGHT-ANGLES TO THE BLADE-AXIS L-05 FT. I_1 0-02 SLUG-(FT.)^2 HIGHER FREQUENCY NOT PLOTTED

1 ton a forward speed through the air of 75 miles per hour, the corresponding thrust being 300 lb., approximately.

Diameter of the air-screw = 9.5 ft.
Mass of the air-screw and metal fittings at the boss, M = 1.0 slug.
Outside diameter of the air-screw shaft = 2 in.
Inside diameter of the air-screw shaft = 0.9 in.
Whence moment of inertia of a section of the air-screw shaft about a diameter = 0.362×10^{-4} ft^4.
Length of the air-screw shaft, L = 0.5 ft.
Mass of 1 ft. length of the air-screw shaft, m = 0.26 slugs.
Modulus of elasticity E = 4.17×10^9 lb. per square foot.
Moment of inertia of the air-screw about an axis passing through the center of the boss at right angles to both the air-screw axis and the blade axis = 3.5 slug-ft.^{2}.
Moment of inertia of the air-screw about the blade axis = 0.02 slug-ft.^{2}.
Hence

$$I_2 = 3.5\sin^2\alpha + 0.02\cos^2\alpha$$

Where α = angle between the blade axis and an axis passing through the center of the boss at right angles to the plane of vibration.

Only the two extreme values of I_2 were taken, namely, 3.5 when $\alpha = 90$ deg. and 0.02 when $\alpha = 0$ deg.

The rate at which energy is dissipated for this air-screw is $150\,\dot{\theta}^2$ ft.-lb. per second, when $\alpha = 90$ deg. The damping when $\alpha = 0$ deg. can be neglected at the commencement of the investigation.

The calculations are quite straightforward, although somewhat laborious, and it has been considered not desirable to

overburden this paper with the complete calculations, so that only a summary of the results is given in the tables and shown graphically in the figures. It will be noted that the frequency of the transverse vibrations of the air-screw as mounted in practice is very high, much higher than the bursting speed of the air-screw, which is about 3500 r.p.m, and, accordingly, calculations were made for the air-screw mounted at the end of a shaft of length 2.5 ft. As stated at the commencement of the investigation it is assumed that the air-screw shaft is rigidly fixed at one end, but it is uncertain how far such a condition holds in practice, much depending on the rigidity of

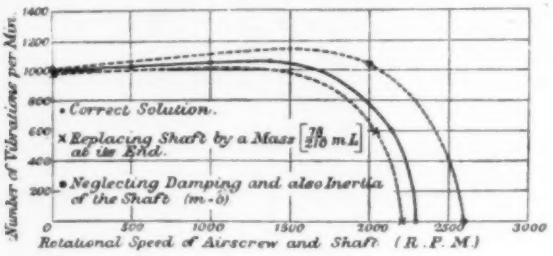


FIG. 4. TRANSVERSE VIBRATIONS IN A PLANE PARALLEL TO THE AXIS OF ROTATION AND TO THE BLADE-AXIS. L-2-5 FT. I_2-3-5 SLUG-(FT.)^2 HIGHER FREQUENCY NOT PLOTTED

the engine frame and the method of mounting the air-screw shaft. Any want of rigidity at the end of the shaft will reduce for the same speed of rotation the frequency of the transverse vibrations. If the end conditions are different from those postulated in the present paper, but are definitely defined, the same method of calculating the frequency of the transverse vibrations may be employed, although the equation of the centre line of the shaft will be different.

The solution of the biquadratic $D^4 + A_1 D^3 + A_2 D^2 + A_3 D + A_4 = 0$ was greatly facilitated by the fact that the terms A_1 and A_3 are of small importance compared with A_2 and A_4, so that the biquadratic could be readily split into two quadratic equations by the method of trial and error. Of course, the solution of the biquadratic equation when the damping terms A_1 and A_3 are neglected is a matter of no difficulty.

From the data of the tables and figures it will be seen that the following conclusions may be drawn:

(*a*) The air damping of an air-screw is negligible, in so far as the frequency of the transverse vibrations is concerned.

(*b*) The whirling speed may be calculated with very good accuracy by assuming the effect of the shaft to be the equivalent of a mass $\frac{78}{210}\, m\, L$ at its end. In this case the whirling speed is overestimated, the inaccuracy increasing with the length of the shaft. The maximum error due to this assumption is only about 3.5 per cent of the true value of the whirling speed.

(*c*) As would be expected, neglecting the mass of the shaft makes the whirling speed too high, the discrepancy increasing with the length of the shaft, the maximum error due to the assumption being 13 per cent. of the true value of the whirling speed.

(*d*) It is seen from Figs. 3 and 5 that even when the moment of inertia I_2 of the air-screw is small—0.02 slug-ft.^{2} in this particular case—it should not be neglected in the calculation of the whirling speed.

(*e*) The whirling speed of an air-screw and shaft increases with the moment of inertia of the air-screw.

(*f*) When the moments of inertia of the air-screw—I_2 in this case—and of the shaft are zero, the whirling speed has the same frequency as the natural period of transverse vibration when not rotating.

A SIMPLE FORMULA FROM WHICH MAY BE CALCULATED THE WHIRLING SPEED OF ROTATION OF AN AIR-SCREW AND ITS SHAFT

It has been shown that the air damping of an air-screw may be neglected, and also that the effect of the inertia of the shaft is equivalent, for all practical purposes, to a mass $\frac{78}{210}\, m\, L$ placed at its end. The differential equation for the motion of the air-screw and shaft then becomes

$$\left\{\left[D^2 + \omega^2 + \frac{4\,E\,I}{L\,I_2}\right]\left[D^2 - \omega^2 + \frac{12\,E\,I}{L^3\left(M + \frac{78}{210} m\,L\right)}\right] - \frac{36\,E^2\,I^2}{I_2\,L^4\left(M + \frac{78}{210} m\,L\right)}\right\}\theta = 0$$

that is

$$D^4 + D^2\left(\frac{4\,E\,I}{L\,I_2} + \frac{12\,E\,I}{L^3\left(M + \frac{78}{210} m\,L\right)}\right) + \left(\omega^2 + \frac{4\,E\,I}{L\,I_2}\right)\left(\frac{12\,E\,I}{L^3\left(M + \frac{78}{210} m\,L\right)} - \omega^2\right) - \frac{36\,E^2\,I^2}{I_2\,L^4\left(M + \frac{78}{210} m\,L\right)}\Bigg\}\theta = 0$$

The whirling speed, that is, the rotational speed at which the frequency of one of the transverse vibrations becomes zero, is then got from the expression

$$\left[\omega^2 - \frac{12\,E\,I}{L^3\left(M + \frac{78}{210} m\,L\right)}\right]\left[\omega^2 + \frac{4\,E\,I}{L\,I_2}\right] + \frac{36\,E^2\,I^2}{I_2\,L^4\left(M + \frac{78}{210} m\,L\right)} = 0$$

which may be written

$$\omega^4 + \omega^2\left[\frac{4\,E\,I}{L\,I_2} - \frac{12\,E\,I}{L^3\left(M + \frac{78}{210}\, m\,L\right)}\right] = \frac{12\,E^2\,I^2}{I_2\,L^4\left(M + \frac{78}{210}\, m\,L\right)}$$

If the above equation be solved for ω^2, it will be found that there is one positive and one negative value. The whirling

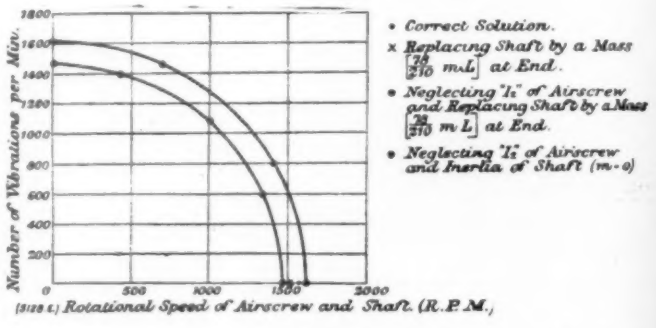


FIG. 5. TRANSVERSE VIBRATIONS IN A PLANE PARALLEL TO THE AXIS OF ROTATION AND TO THE BLADE-AXIS L-2-5 FT. I_2-0-02 SLUG-(FT.)^2 HIGHER FREQUENCY NOT PLOTTED

speed may be got by taking the square root of the positive value of ω^2. The result of the present investigation may be summarized as follows.

The critical speed, ω, of a rotating air-screw and shaft, the shaft being a cantilever fixed in direction at one end, may be calculated by taking the square root of the positive value of ω^2 got from the solution of the equation

$$\omega^4 + \omega^2\left(\frac{4\,E\,I}{L\,I_2} - \frac{12\,E\,I}{L^3\left(M + \frac{78}{210}\, m\,L\right)}\right) = \frac{12\,E^2\,I^2}{I_2\,L^4\left(M + \frac{78}{210}\, m\,L\right)}$$

where

ω = rotational speed in radians per second.
M = mass of the air-screw in slugs.
I_2 = moment of inertia of the air-screw about an axis passing through the center of the air-screw at right-angles to the plane of the transverse vibrations (slug-ft.^{2}).
L = length of the shaft in feet.
m = mass of one foot length of shaft in slugs.
E = Young's modulus in lb. per square foot.
I = moment of inertia of a cross-section of the shaft about a diameter in feet^4

If $I_2 = 0$ the whirling speed may be calculated from the equation

$$\omega^2 = \frac{3\,E\,I}{L^3\left(M + \frac{78}{210}\, m\,L\right)}$$

TABLE I.—*Summary of the Results of the Calculations made on a Modern Two-bladed Air-screw, Mounted as in practice on a Shaft of Length 0.5 ft.*

Case I.—Transverse vibrations in a plane parallel to the axis of rotation and to the blade axis. $\alpha = 90$ deg. and $I_2 = 3.5$ slug-ft.^{2}. Bursting speed of air-screw about 3,500 r.p.m.

Assumptions made in Calculations.	Rotational Speed of the Shaft (r.p.m.).	Number of Vibrations per Minute.	
Complete solution, making no assumptions	0	2,770	35,800
	5,000	5,900	35,600
	10,000	10,100	34,200
	15,000	14,800	31,600
	20,000	19,000	29,700
	25,000	21,700	28,800
	30,000	17,800	31,400
	34,000	9,000	34,900
	35,000	0	35,800
Neglecting damping only	Results same as with no assumptions		
Neglecting damping and assuming effect of shaft to be equivalent of a mass $\left(\frac{78}{210} m\ L\right)$ at its end	0	2,785	35,800
	28,700	19,400	30,300
	35,100	0	35,600
Neglecting damping and also the inertia of the shaft ($m = 0$)	0	2,755	36,700
	4,000	5,100	36,700
	9,000	9,200	36,000
	14,000	13,900	33,800
	19,000	18,200	31,700
	24,000	21,500	30,200
	29,000	19,800	30,900
	34,000	12,000	34,900
	36,000	0	36,700

TABLE II.—*Summary of the Results of the Calculations made on a Modern Two-bladed Air-screw, Mounted as in Practice on a Shaft of Length 0.5 ft.*

Case II.—Transverse vibrations in a plane parallel to the axis of rotation and at right angles to the blade axis. $\alpha = 0$ deg. and $I_2 = 0.02$ slug-ft.^{2}. No damping in this case. Bursting speed of air-screw about 3,500 r.p.m.

Assumptions made in the Calculations.	Rotational Speed of the Shaft (r.p.m.).	Number of Vibrations per Minute.	
Complete solution, making no assumptions	0	16,600	78,800
	4,000	16,400	79,000
	10,000	14,400	80,000
	16,000	9,300	81,600
	19,000	3,800	82,700
	19,500	0	82,900
Assuming effect of the shaft to be equivalent to a mass $\left(\frac{78}{210} m\ L\right)$ at its end	0	16,400	Not calculated.
	19,300	0	
Neglecting I_2 which is very small in this case, and assuming effect of the shaft to be equivalent to a mass $\left(\frac{78}{210} m\ L\right)$ at its end	0	17,750	
	17,750	0	
Neglecting I_2 and also the mass of the shaft ($m = 0$)	0	18,150	
	18,150	0	

TABLE III.—*Summary of the Results of the Calculations made on a Modern Two-bladed Air-screw, Mounted at the End of a Long Shaft of Length 2.5 ft.*

Case I —Transverse vibrations in a plane parallel to the axis of rotation and to the blade axis. $\alpha = 90$ deg. and $I_2 = 3.5$ slug-ft.^{2}.

Assumptions made in Calculations.	Rotational Speed of the Shaft (r.p.m.).	Number of Vibrations per Minute.	
Complete solution, making no assumptions	0	1,000	3,640
	500	1,200	3,630
	1,000	1,060	3,620
	1,400	1,070	3,620
	1,800	950	3,650
	2,200	490	3,750
	2,290	0	3,770
Neglecting damping makes practically no difference to the frequency			
Neglecting damping and assuming effect of the shaft to be the equivalent of a mass $\left(\frac{78}{210} m\ L\right)$ at its end	0	990	3,720
	1,910	760	3,770
	2,220	0	3,780
Neglecting damping and also the inertia of the shaft ($m = 0$)	0	1,020	Not calculated.
	1,910	1,095	
	2,590	0	

TABLE IV.—*Summary of the Results of the Calculations made on a Modern Two-bladed Air-screw, Mounted at the End of a Long Shaft of Length 2.5 ft.*

Case II.—Transverse vibrations in a plane parallel to the axis of rotation and at right angles to the blade axis. $\alpha = 0$ deg. and $I_2 = 0.02$ slug-ft.^{2}. No damping in this case.

Assumptions made in the Calculations.	Rotational Speed of the Shaft (r.p.m.).	Number of Vibrations per Minute Frequency of the Higher Vibrations not Calculated.
No assumptions	0	1,500
	1,565	0
Assuming effect of the shaft to be the equivalent of a mass $\left(\frac{78}{210} m\ L\right)$ at its end	0	1,480
	1,510	0
Neglecting I_2, which is very small, and assuming effect of the shaft to be the equivalent of a mass $\left(\frac{78}{210} m\ L\right)$ at its end	0	1,460
	1,460	0
Neglecting I_2 and mass of shaft ($m = 0$)	0	1,620
	1,620	0

The Nieuport 1½ Plane Fighter

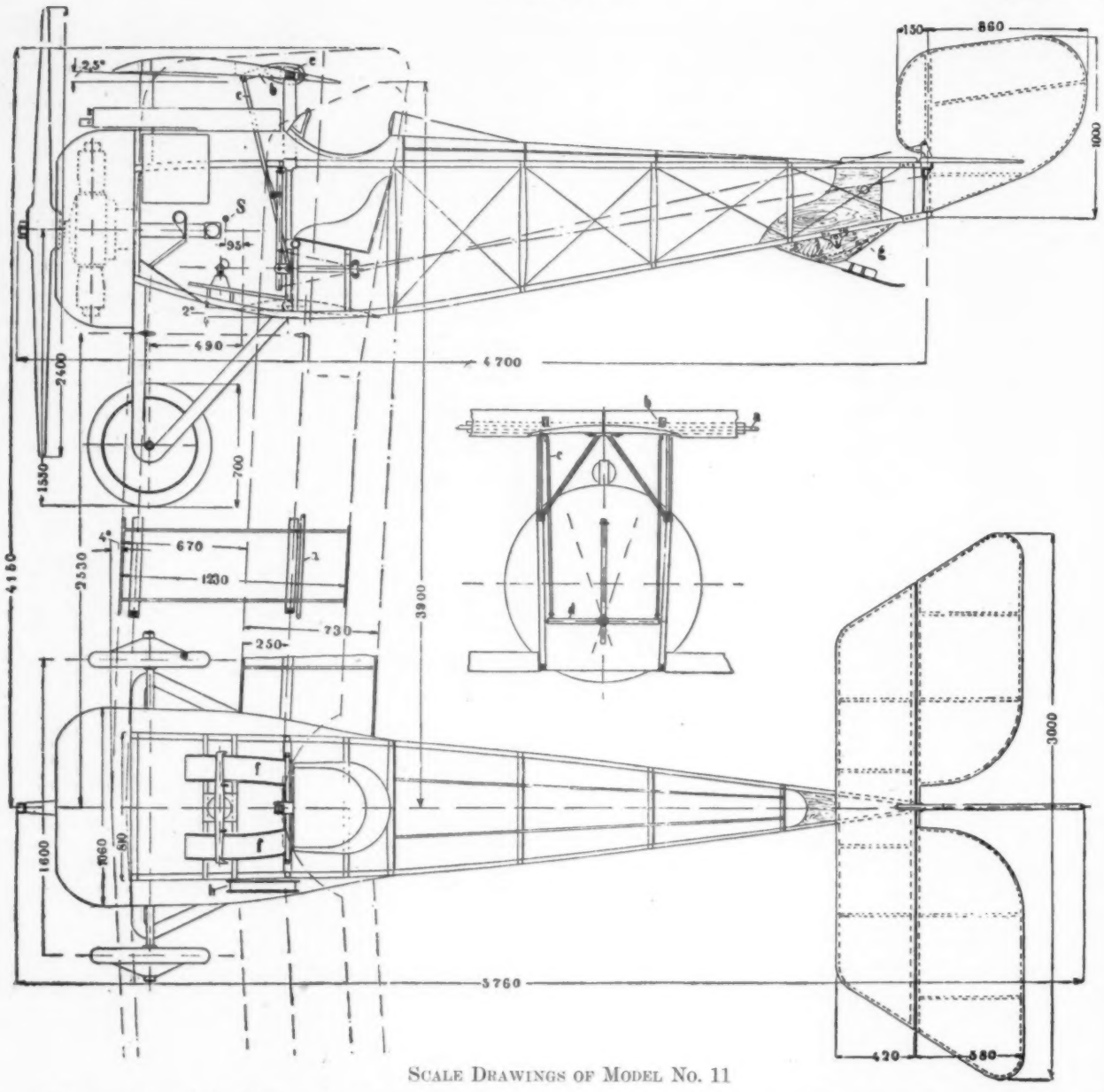
The Nieuport 1½ plane has, during the last year, become one of the most important fighter airplanes of the French Flying Corps, being in no mean way responsible for the aerial supremacy achieved by the Allies both on the Western and the Italian fronts. The following data and constructional details are abstracted from articles appearing in German aeronautical magazines.

Although various models exist, and often vary in minor details, the 1½ plane fighter is essentially a one-seater tractor biplane fitted with a rotary engine. Two-seater machines have also been built, but do not appear to be very widely employed. These are chiefly used for reconnaissance work and only occasionally for fighting. The forward gun fires through the propeller, while the after gun is mounted *en barbette*.

Official French Photograph

THE NIEUPORT BIPLANE

Model No. 11, produced in 1916 and since superseded by improved types, seems to have remained the prototype of the Nieuport 1½ plane fighter. Its constructional data are therefore of particular interest.



SCALE DRAWINGS OF MODEL NO. 11

Characteristics of the Nieuport Model No. 11

Span, upper	24 ft. 8 in.
Span, lower	24 ft. 3¼ in.
Chord, upper	3 ft. 11 in.
Chord, lower	2 ft. 5 in.
Overall length	18 ft. 10 in.
Height	8 ft. 1 in
Area, upper plane, with ailerons	97 sq. ft.
Area, lower plane	49.5 sq. ft.
Area, stabilizer	11 sq. ft.
Area, elevators	14.5 sq. ft.
Area, rudder	6 sq. ft.
Area, ailerons	14 sq. ft.
Stagger	2 ft. 3 in.
Dihedral, upper	179 deg.
Dihedral, lower	174 deg.
Retreat	170 deg. 30′
Incidence, upper	1 deg. 30′
Incidence, lower	3 deg.
Power plant	80 hp. Le Rhône
Propeller, diameter	8 ft. 2½ in.
Climb	3,300 ft. in 4 min.
	6,600 ft. in 7 min.
	9,900 ft. in 11 min.
	13,200 ft. in 16 min.

Apportionment of Weights

Upper plane, complete	79 lb.
Lower plane, complete	32 lb.
Stabilizer	7.7 lb.
Elevators	9.5 lb.
Rudder	6.6 lb.
Body, with engine complete	583 lb.
Wire stays	7.7 lb.
Wheels	22.4 lb.
Struts, interplane	11 lb.
Gross weight (empty)	760 lb.
Pilot	176 lb.
Gasoline (20½ gal.)	121 lb.
Oil (5 gal.)	44 lb.
Machine gun and ammunition	110 lb.
Useful load	451 lb.
Total weight (loaded)	1210 lb.
Lift loading	8.3 lb./sq. ft.
Power loading	12.1 lb./hp.

Among the more notable constructional features of the Nieuport is the use of a single spar in the lower wing, the consequent adoption of V-type struts and the possibility of varying the incidence on assembling; the novel method of mounting the ailerons on a tubular shaft carried all across the wing, and their operation by means of pull-and-push rods instead of control cables; and the rather startling use of aluminum alloy in the chassis construction. The cross member of the chassis connecting the V's is of channel section aluminum, while the chassis struts consist of drawn aluminum tubes. The wheel axle is, however, a steel tube, and the strut sockets are made of steel sheeting.

Model No. 17, which appears to be one of the latest models of the Nieuport fighter, is but slightly larger than the Model No. 11 and is chiefly remarkable for the circular section of the body in the neighborhood of the cockpit, and the spinner fitted to the propeller to reduce head resistance. Model No. 17 has a 110 hp. Le Rhône or a 130 hp. Clerget engine. It is worth noting that, unlike on the prototype, the lower plane is mounted at a lesser incidence than the upper plane and that the décalage between the planes is also much reduced. The incidence of the upper plane is 2 deg. 30′, and that of the lower plane 2 deg.

The armament of the Nieuport fighter consists of one or two Lewis guns; if two are carried, one is generally mounted on the upper plane, while the other is mounted on the body in front of the pilot. Both emplacements are of the stationary type, and a synchronizing device is provided for firing the lower gun through the propeller, which the upper gun is prevented from doing by an appropriate guide.

Completion of the Liberty Engine

The successful completion of the U. S. A. or Liberty aircraft engine was announced in an official statement issued by the Secretary of War on August 12. The statement reads:

"The United States aviation engine has passed its final tests. They were successful and gratifying. The new engine, designated by the Signal Service as the 'Liberty engine,' is now the main reliance of the United States in the rapid production in large numbers of high-powered battle planes for service in the war. In power, speed, serviceability and minimum weight the new engine invites comparison with the best that the European war has produced.

"I regard the invention and rapid development of this engine as one of the really big accomplishments of the United States since its entry into the war. The engine was brought about through the cooperation of more than a score of engineers, who pooled their skill and trade secrets in the war emergency, working with the encouragement of the Aircraft Production Board, the War Department and the Bureau of Standards.

"The story of the production of this engine is a remarkable one. Probably the war has produced no greater single achievement.

"One of the first problems which confronted the War Department and the Aircraft Production Board after the declaration of hostilities was to produce a dependable engine. Two courses were open. One was to encourage manufacturers to develop their own types, the other to bring the best of all types together and develop a standard.

"The necessity for speed and quantity of production resulted in a choice of the latter course, and a standard engine became our engineering objective.

"Two of the best engineers in the country, who had never before seen each other, were brought together at Washington, and the problem of producing an all-American engine at the earliest possible moment was presented to them. Their first conference, on June 3, lasted from afternoon until half-past two o'clock in the morning.

"These two engineers were figuratively locked in a room in a Washington hotel and charged with the development of an airplane engine for use by American aviators over the battlefields of Europe. For five days neither man left the suite of rooms engaged for them. Consulting engineers and draftsmen from various sections of the country were brought to Washington to assist them. The work in the drafting room proceeded continuously, day and night. Each of the two engineers in immediate charge of engine development alternately worked a twenty-four-hour shift.

"An inspiring feature of this work was the aid rendered by consulting engineers and motor manufacturers, who gave up their trade secrets under the emergency of war needs. Realizing that the new design would be a Government design and no firm or individual would reap selfish benefit because of its making, the motor manufacturers patriotically revealed their trade secrets and made available trade processes of great commercial value. These industries have also contributed the services of approximately 200 of their best draftsmen.

"The two engineers locked together in a hotel room in this city promised the Government if given an opportunity they would design a satisfactory aero-engine before a working model could be brought from Europe.

"A remarkable American engine was actually produced three weeks before any model could have been brought from Europe. It was promised that this engine would be developed before the Fourth of July. Twenty-eight days after the drawings were started the new engine was set up. This was on July 3.

"In order to have the engine in Washington and in actual running order at the nation's capital on Independence Day the perfected engine was sent from a Western city in a special express car. The journey was made in twenty-one hours, and four young men guarded the engine en route to Washington and personally attended to its transfer from one railroad to another.

"With the need for speed as an incentive, tools for building the first engine were made even before the drawings were finished—on the assumption that they would be correct.

"Parts of the first engine were turned out at twelve different factories, located all the way from Connecticut to California. When the parts were assembled the adjustment was perfect and the performance of the engine was wonderfully gratifying. This in itself demonstrated the capabilities of American factories when put to the test and when thoroughly organized for emergency work of this sort.

"One of the chief rules outlined at the beginning of the designing work was that no engineer should be permitted to introduce construction which had not been tried out. There was no time for theorizing. The new engine is successful because it embodies the best thought of engineering experience to date. Not only did this country furnish ideas through celebrated consulting engineers, but the representatives in the United States of England, France and Italy cooperated in the development of this motor.

"Thirty days after the assembling of the first engine preliminary tests justified the Government in formally accepting the engine as the best aircraft engine produced in any country. The final tests confirmed our faith in the new engine in every degree.

"Both the flying and altitude tests of the new engine have been gratifying. One test was conducted at Pike's Peak, where the United States aviation engine performed satisfactorily at this high altitude. One of the engines in an airplane broke the American altitude record in a recent flying test.

"While it is not deemed expedient to discuss in detail the performances and mechanics of the new engine, it may be said that standardization is a chief factor in the development of the Government's engine. Cylinders, pistons and every other part of the engine have been standardized. They may be produced rapidly and economically by a great many factories operating under Government contracts. They may be as rapidly assembled, either by these plants or at a central assembly plant.

"The new engine amounts practically to an international model. It embodies the best there is in American engineering and the best features of Europan models, so far as it has been possible to adapt the latter to American manufacturing methods.

"The two engineers most directly connected with the production of the United States aviation engine had before them not only the blueprints and models of the most successful engines the war has produced but also every available American suggestion. Men skilled in the invention of motors, both automobile and airplane, advised these engineers who were charged with the duty of providing rapidly and unerringly an engine which would embody every essential of war time use. Non-essential complexities were consistently discarded by these engineers. The result was a composite design of maximum power, minimum weight, great speed capability and adaptability to quick production.

"The standardization of parts materially simplifies the problem of repair and maintenance. Spare parts will be promptly available at all times. Even the cylinders are designed separately. It is possible to build the new engine in four models, ranging from four to twelve cylinders, and under the standardization plan now worked out an eight-cylinder or a twelve-cylinder model can be made, using the same standard cylinders, pistons, valves, cam shafts, and so on.

"With the completion of final tests of the engine—tests which satisfied and gratified both expert engineers and army officers—progress already has been made toward organizing industry for the manufacture of the new machines and deliveries will begin within a comparatively short time."

NOTE:—At the request of the War Department no further information concerning the design, performance or manufacture of this engine will be printed at this time.—EDITOR.

The Sylphon Motor Thermostat

Proper control of the temperature of the cooling medium of an internal combustion engine, adds much to the efficiency, economy, and satisfactory operation. There is one temperature of the medium at which the motor will give best results, and the ideal condition is to maintain this temperature constant. The Sylphon automobile thermostat accomplishes this in a simple manner.

In the case of a water-cooled engine, a by-pass is installed between the engine jacket intake and outlet, as shown by Figs. 2 and 3. By this means, water may pass out of the jacket through the by-pass and back into the jacket without circulating through the radiator. Whether the water circulates through the radiator or through the by-pass is

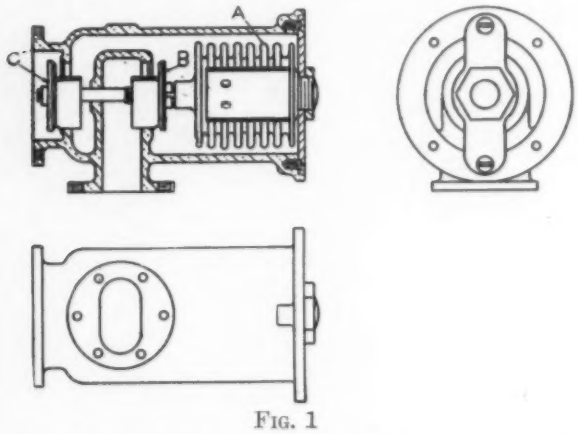


FIG. 1

determined by the Sylphon thermostatic valve shown in Fig. 1.

The radiator valve, *C*, and the by-pass valve, *B*, are mounted on the same spindle—therefore, as either valve closes, the other opens. This double valve is moved by the Sylphon, *A*, which consists of an hermetically sealed, seamless, corrugated, metal vessel, containing a volatile liquid. Changes in temperature of the circulating water bring about changes

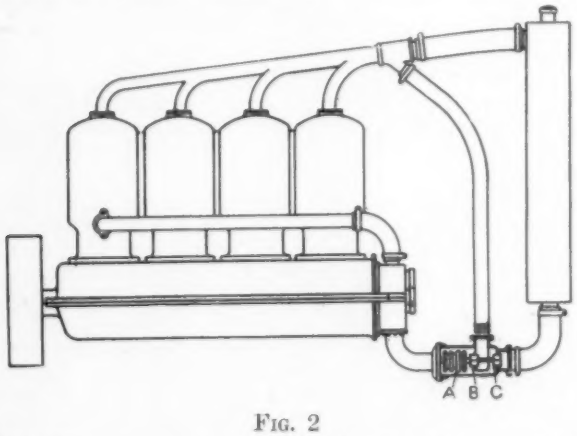


FIG. 2

in the vapor pressure of the volatile liquid, causing the Sylphon to expand or contract and producing motion of the valve.

By proper choice of the liquid it is evident that the thermostat may be set to open the valve allowing water to circulate through the radiator at a definite temperature. Any tendency to exceed this temperature is offset by the thermostat, which closes the by-pass and directs sufficient water through the radiator to reduce the temperature of the water in the jacket.

The radiator is designed to keep the cooling water at the efficient temperature during hard service in hot weather. Now if the motor operates most economically when the air temperature is 85 deg. F., the cooling medium around the cylinders is not at the proper temperature when the air is below this temperature, other things being constant.

Often the radiator is covered to secure satisfactory operation of the air temperature is around 0 deg. F. The Sylphon thermostat eliminates this difficulty. Also when starting, efficient operating temperature of motor is quickly reached, carburetor adjustment for weather conditions is unnecessary and lubrication is improved. With the motor stopped, the cooling medium loses heat more slowly. Metals having large coefficients of expansion may be used in engine construction and when two fuels are used, correct preheating of the

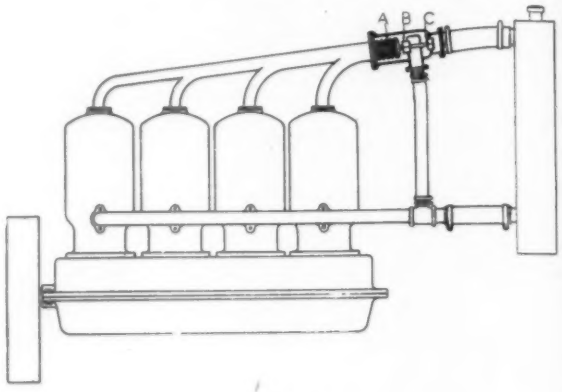


FIG. 3

operating fuel may be accomplished by passing the cooling medium through heating coils in the fuel passage.

The Sylphon thermostat may be used with any cooling medium and may be applied to any motor with perhaps a slight change in the design of the housing. A series of careful tests show a marked improvement in the economy of automobile engines using this device.

The Fulton Co. of Knoxville, Tenn., manufacturer of the Sylphon, is now working on an airplane thermostatic regulator.

Bain News Service *British Official Photograph*

BRITISH KITE-BALLOON IN TOW

Wire and Cable Standards Recommended by S. A. E.

The following extracts from the report of the Advisory Committee for Airplane Material, Specifications and Inspection were recommended for standardization at the Washington meeting of the S. A. E.

Aircraft Round Wire

This specification covers solid high strength steel wire, round section, used in the construction of aircraft when flexibility is of minor importance. A tension test is to be made on each piece or coil of wire. When an individual coil of wire is to be divided into smaller coils to meet special requirements it is sufficient to make one test on the original coil and to cut and seal the smaller coils in the presence of the inspector. Samples for tension test shall be no less than 15 in. long and free from bends and kinks.

TABLE OF PHYSICAL PROPERTIES FOR AIRCRAFT ROUND WIRE

Brown & Sharpe Gage	Diameter, In.	Minimum Torsion for 6 In.	Weight in Lb. per 100 Ft.	Number of Bends Through 90 deg.	Breaking Strength, Minimum Lb.
6	0.162	11	7.01	5	4,500
7	0.144	12	7.01	6	3,700
8	0.128	14	4.40	8	3,000
9	0.114	16	3.50	9	2,500
10	0.102	18	2.77	11	2,000
11	0.090	21	2.20	14	1,620
12	0.081	24	1.744	17	1,300
13	0.072	27	1.383	21	1,040
14	0.064	31	1.097	25	830
15	0.057	34	0.870	29	660
16	0.051	39	0.690	34	540
17	0.045	44	0.547	42	425
18	0.040	49	0.434	52	340
19	0.036	55	0.344	70	280
20	0.032	61	0.273	85	225
21	0.028	70	0.216	105	175

In making tensile tests on aircraft wire the distance between jaws of testing machine with sample in place and before test shall be 10 in. Wire for this purpose must break at no less than the amount specified in the attached table which herewith becomes a part of this specification.

A torsion test is to be made on a sample cut from each piece or coil of wire as above. Samples for torsion tests shall be straight and no less than 10 in. long. The sample shall be gripped by two vises 6 in. apart; one vise shall be turned uniformly at a speed not exceeding 60 r.p.m. (on the larger sizes of wire this speed shall be reduced sufficiently to avoid undue heating of the wire). One vise shall have free axial movement in either direction. All wire shall be required to stand the minimum number of complete turns shown in the attached table.

A bend test is to be made on a sample cut from each piece of wire as above. Sample for bend test shall be straight and no less than 10 in. long. One end of the sample shall be clamped between jaws having their upper edges rounded to 3/16-in. radius. The free end of the wire shall be held loosely between two guides and bend 90 deg. over one jaw; this is to be counted as one bend. On raising to a vertical position the count will be two bends. Wire shall then be bent to the other side, and so forth, alternating to fracture. The minimum number of bends required is stated in the following table.

A wrapping test is to be made on at least 10 per cent of the total number of coils offered for inspection at one time. The wire shall be tightly wrapped eight consecutive turns around its own diameter with a pitch of substantially the diameter of the wire and then unwrapped maintaining the free end at approximately 90 deg. with the mandril.

It must stand this test without fracture. Because of the possibility of personal error in making this test, failure on one test is not considered conclusive and, if requested to do so, the inspector shall make at least one, but no more than two additional tests on the same piece of wire. If any of these tests are successful the material shall be passed as satisfactory in this respect.

All wire for this purpose shall be furnished in decimal sizes corresponding to the American Standard Wire Gage (Brown & Sharpe Gage). The wire shall be cylindrical and smooth and show no evidence of scrapes, splints, cold shuts and rough tinning, not conforming with best commercial practice. A permissible variation of 0.002 in. above gage on all sizes will be acceptable, but no wire will be accepted having a variation of more than 0.0005 in. below gage.

Single strand, multiple strand 6 by 7, 7 by 7, and 7 by 19.

A tensile test shall be made upon each individual reel of cable for shipment containing 10,000 ft. or more. On shipments of reels of cable containing less than 10,000 ft., each test shall be made for each 5000 ft. of a size. The tension testing machine shall be of a type satisfactory to the representative of the U. S. Government and shall be standardized with U. S. Standard Weights when considered necessary. Samples of cable for testing for tensile strength shall be no less than 24 in. long. In making tensile tests the distance between jaws of testing machine with sample in place and before test shall be no less than 10 in. Samples for tensile test may be clamped in the jaws of the testing machine in the usual manner to facilitate speed of testing, but in case of failure or dispute on individual tests and at the request of the manufacturer, check tests shall be made by socketing the samples with pure zinc. Cables

AIRCRAFT GALVANIZED SINGLE STRAND CABLE (Non-flexible)

Diameter of Cable, in.	Number of Wires	Breaking Strength of Cable, lb.	Approximate Weight lb. per 100 ft.
1/16	19	12,500	20.65
1/4	19	8,000	13.50
3/16	19	6,100	10.00
7/32	19	4,600	7.70
1/8	19	3,200	5.50
5/32	19	2,100	3.50
3/16	19	1,600	2.60
7/32	19	1,100	1.75
1/8	19	780	1.21
5/32	19	500	0.78
3/16	7	185	0.30

AIRCRAFT GALVANIZED MULTIPLE CABLE *6x7 COTTON CENTER (Flexible)

Diameter of Cable, In.	Breaking Strength of Cable, lb.	Approximate Weight lb. per 100 ft.
1/16	7,900	15.00
1/4	5,000	9.50
3/16	4,000	7.43
7/32	2,750	5.30
1/8	2,200	4.20
5/32	1,150	2.20
3/16	830	1.50
7/32	780	1.30
1/8	480	0.83
5/32	400	0.73

* Six strands of seven wires each.

REELS FOR AIRCRAFT STRAND AND CABLE*

Diam. of Strand or Cable	Diam. Head	Trav. or Dist. betw'n Heads	Diam. Bbl.	Diameter Arbor Hole	Diam. Head	Trav. or Dist. betw'n Heads	Diam. Bbl.	Diameter Arbor Hole
	1000 FEET				3000 FEET			
1/16	12	4	8	1 1/16	12	4	8	1 1/16
1/4	12	4	8	1 1/16	12	4	8	1 1/16
3/16	12	4	8	1 1/16	16	4	10	1 1/16
7/32	12	4	8	1 1/16	16	4	10	1 1/16
1/8	16	4	10	1 1/16	16	7	12	1 1/16
5/32	16	4	10	1 1/16	16	7	12	1 1/16
3/16	16	7	12	1 1/16	16	10	8	1 1/16
7/32	16	7	12	1 1/16	16	10	8	1 1/16
1/8	18	7	12	2 1/16	18	10	8	2 1/16
5/32	18	7	12	2 1/16	18	10	8	2 1/16
3/16	18	10	10	2 1/16	24	10	10	2 1/16
7/32	18	10	10	2 1/16	24	10	10	2 1/16
1/8	18	10	8	2 1/16	32	16	16	2 1/16
5/32	18	10	8	2 1/16	32	16	16	2 1/16
	5000 FEET				10,000 FEET			
1/16	12	4	8	1 1/16	16	4	10	1 1/16
1/4	16	4	10	1 1/16	16	4	12	1 1/16
3/16	16	7	12	1 1/16	16	10	8	1 1/16
7/32	16	7	12	1 1/16	16	10	8	1 1/16
1/8	16	10	8	1 1/16	18	10	8	1 1/16
5/32	16	10	8	1 1/16	24	10	10	1 1/16
3/16	24	10	10	1 1/16	24	16	10	2 1/16
7/32	24	10	10	1 1/16	24	16	10	2 1/16
1/8	24	10	10	2 1/16	24	16	10	2 1/16
5/32	24	10	10	2 1/16	32	20	16	3 1/16
3/16	32	18	16	2 1/16	36	22	18	3 1/16
7/32	32	18	16	2 1/16	36	22	18	3 1/16
1/8	32	20	16	3 1/16	50	16	26	3 1/16
5/32	32	20	16	3 1/16	50	16	26	3 1/16

In making racks for the above reels allow 4 inches more width than the traverse specified above. *All dimensions in inches.

for use in the construction of aircraft must break at no less than the amount specified in the attached table.

At least one bending test is to be made on a sample cut from each 50,000 ft. of cable of a given size. Each sample must be bent once around its own diameter and straightened again at least 20 times in succession in the same direction of bending without any of the wires breaking.

A torsion test is to be made on one wire from each sample of cable taken for tensile test. The wire is to be gripped by

Aircraft Galvanized Multiple Cable *7x7 Wire Center (Flexible)

Diameter of Cable, in.	Breaking Strength of Cable, lb.	Approximate Weight lb. per 100 ft.
1/4	9,200	16.70
15/64	5,800	10.50
7/32	4,600	8.30
13/64	3,200	5.80
3/16	2,600	4.67
11/64	1,350	2.45
5/32	970	1.75
9/64	920	1.45
1/8	550	0.93
7/64	480	0.81

* Seven strands of seven wires each.

Aircraft Tinned Multiple Strand Cable *7x19 Wire Center (Extra Flexible)

Diameter of Cable, in.	Breaking Strength of Cable, lb.	Approximate Weight lb. per 100 ft.
3/8	14,400	26.45
11/32	12,500	22.53
5/16	9,800	17.71
9/32	8,000	14.56
1/4	7,000	12.00
7/32	5,600	9.50
3/16	4,200	6.47
5/32	2,800	4.44
1/8	2,000	2.88

* Seven strands of nineteen wires each.

two vises 4 in. apart; one vise shall be turned uniformly at as high a rate of speed as possible without perceptibly heating the wire. One vise shall have free axial movement in either direction. The number, N, of whole turns through which the wire must stand twisting is given by the formula:

$$N = \frac{1.1}{d}$$

where d equals the diameter of the wire in inches. Failure of one piece of wire to show full number of turns specified in the above torsion test shall not be considered cause for rejection, but in each case two additional tests shall be made on two more wires from the same sample of cable and if both samples meet the requirements of the specifications the strand shall be accepted in this respect.

No variation is permissible below nominal diameter. Cable having a diameter of 1/32 to 5/32 in. inclusive shall have a permissible variation of 10 per cent. above size and cable having a diameter of 3/6 to 3/8 in. inclusive shall have a permissible variation of 7 per cent above size.

Protective Coatings for Metals

The Aeronautic Division of the Standards Committee of the S. A. E. is now engaged in a study of the various kinds of anti-rust treatment of metals. This subject is exceedingly important at present, on account of the need for protecting many of the bolts, nuts and fittings used on aircraft from the action of the elements. It is planned to secure as many samples as possible of treatments making use of chemical or heat methods or a combination of the two, for protecting metals.

The Boyce Motometer

The Boyce Distance Type Motometer consists essentially of three main parts: the temperature responsive element or bulb, the flexible copper tubing which connects the bulb to the third part, the recording instrument.

The advantages of this instrument over the familiar Boyce motometer, so commonly seen on automobile radiators, are two-fold. In the first place, the temperature responsive element is located in the circulating water, and the temperature indicated on the registering dial is the actual temperature of

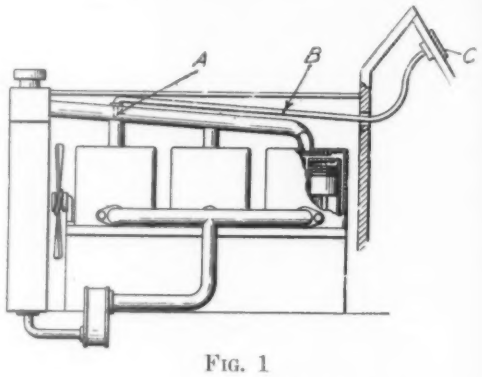


Fig. 1

the water, and not the temperature of the air above the water in the radiator, as is the case with the older type. Secondly, the indicating dial and mechanism can be placed on the dash of the automobile or on the instrument board of the airplane. This makes it far more convenient to read, and at the same time places the indicating mechanism in a position where there is less vibration from the engine.

The temperature responsive element is nothing more than a hollow bulb filled with an expansible fluid. This bulb is located in the cooling system, preferably in such a place as to be influenced by the cooling water after it has attained its highest temperature, and where it will be subject to the action of any steam which may form in the jackets.

The bulb is connected with the flexible hollow tube, which is also filled with the expansible fluid. The other end of the tube is carried to the instrument board, where it connects with the registering instrument. This part of the instrument com-

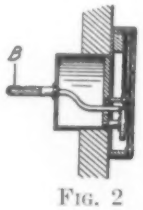


Fig. 2

Fig. 3

prises a Bourbon tube, with the exterior of which the bore of the flexible tube communicates, the free end of the Bourbon tube being connected by a suitable mechanism to the indicating number. Any increase in temperature of cooling water will cause the fluid in the bulb to expand, the pressure in the Bourbon tube will increase, and, in accordance with a well-known principle, it will tend to straighten out and bring the recording hand into play by a system of levers. Conversely, a cooling of the water will cause the fluid in the bulb to contract, thus relieving pressure in the Bourbon tube and permitting recording hand to return to its initial position. Any suitable temperature scale may be employed.

In Fig. 1, the responsive bulb is shown located at *A*, with the flexible tube *B* leading to the Bourbon tube at *C*. Figs. 2 and 3 illustrate diagramatically the construction of the Bourbon tube and of the recorder.

New Aluminum Production Method

A method has recently been patented in this country for obtaining aluminum from aluminum carbide. The latter is mixed with 10 to 20 per cent, by weight, of oxide, chloride and sulphide of aluminum, and the charge is then reduced in a vertical electric furnace at 2100 to 2200 deg. C. under a pressure of 10 to 15 lb. per sq. in. above atmospheric. When alloys are required, oxide, chloride, or sulphide of the respective metal is added in such proportion as to obtain a neutectic alloy. In the case of copper, for instance, the proportions would be copper 5.8 per cent and aluminum 94.2 per cent.

Digest of the Foreign Aeronautical Press

Aeronautics (London), August 9, 1917

Aircraft Losses in July.—Our Air Service overseas had three famous days last month. The first was July 11, when our aerial activity seems to have borne no special relation to operations in the field. At any rate, our men destroyed fourteen German machines and drove down sixteen out of control, while another was shot down by gunfire from the ground. Again, as the inevitable prelude to battle nowadays, we got really busy before the third battle of Ypres. On July 28 we destroyed fifteen enemy machines and drove down sixteen out of control, and on the following day we crashed sixteen and caused another fourteen to spin down earthward. On these three days alone, therefore, we definitely accounted for 46 Germans, while the fate of 48 others is uncertain. Our loss for those three days was 25 machines missing, not all of which necessarily crashed or were brought down as the result of air fighting. The following are the complete figures of the month's losses on the Western front:

Destroyed by British in aerial combat, including four machines which fell in our lines and nine destroyed on returning from raids on England	131
Destroyed by British gunfire, including two in our lines	5
Destroyed by British trawler on East Coast	2
Destroyed by French in aerial combat	47
Destroyed by French gunfire	8
Destroyed by Belgians in aerial combat	6
Destroyed by Belgian artillery	2
Total German loss	201
Number driven down by British out of control, including one by anti-aircraft fire	127
Number driven down in enemy lines by French	54
Total	181
Total number of English machines missing	92
Total number of Allied machines claimed as destroyed by the enemy, including one French machine in Westphalia and two anti-aircraft victims	130

One word of caution. The term "driven down out of control" should not be taken too literally, for a spinning nose-dive is today one of the accepted battle maneuvres.

The American Air Service in France.—Evidence of the close cooperation between the American Air Service and that of the Allies, and of the earnestness of the effort about to be put forward by the United States—if it were needed—is afforded by the character and record of the men our latest Ally is sending over to prepare the way for her. On Aug. 2 Lieut.-Colonel Mitchell, director of the American Air Service in France, was the guest of honor at a reception given by the Aero Club of France in Paris, whereat he was presented with a silver medal. Speeches were made by the president of the club, M. d'Estournelles de Constant, the well-known Senator, and M. Daniel Vincent, Under-Secretary for Military Aeronautics. Lieut.-Colonel Mitchell possesses a fine record as a soldier, having been through the campaigns in Mexico, Cuba and the Philippines as a combatant, and the Russo-Japanese War as military attaché. He has passed the French tests as a fighting pilot and holds the Croix de Guerre awarded him for a noteworthy bombing raid over German territory.

Aeronautics (London), August 15, 1917

A Visit to a Bombing Group.—Hugues le Roux, aeronautical editor of the Paris Daily *Le Matin*, gives an interesting description of his visit to a French bombing "group," the latter unit being the equivalent of the American and English "wing" and consisting of three or more squadrons.

"By day bombs are released from a great altitude. This makes for inaccuracy of aim, but at the same time renders them more effective against the population of big cities, especially when the streets are crowded.

"Destruction raids are better carried out at night. They meet with practically no interference from the enemy, and can be effected from a height of 2,500 to 5,000 feet.

"Sometimes, pilots have told me, we come down as low as 1,500 feet over a railway station; this gives one the sensation of depositing the bomb with your hand, as it were. During the month of June our group dropped 3,700 lb. of bombs in daylight raids and 135 tons in night raids. When our men dropped 3,500 lb. of bombs on the railway and aerodrome of Chateled-sur-Retourue, the enemy admitted that close to $5,000,000 worth of munitions were destroyed in the fire which broke out.

"In short distance raids there is not much to choose between the French and the German, but in long distance raids the French are unquestionably superior. They carry them out almost daily. Treves (68 miles), Karlsruhe (109 miles), Ludwigshafen (124 miles), Coblentz (155 miles), Rottweil (93 miles), Essen (235 miles), Munich (217 miles), Stuttgart, Luxemburg, Dillingen, Sarrebruck are all within reach of their bombing squadrons.

"When questioned about the future, a pilot made the following reply, which is particularly interesting in view of America's air program: 'The aerial establishment attached to army corps (that is, reconnaissance and artillery airplanes) is now adequate. Fighting machines, both in quality and quantity, must be superior to those of the enemy. There lies their limit. But there are no limits to the expansion of the bombing branch of the service. There is no material obstacle in the way of our possessing 500,000 bombers one day. Landing grounds abound in Champagne in the sectors of Noyon and Soissons, and this, our dream, we present to our new Allies over the water.'"

Aeronautics (London), August 22, 1917

The British Air Service Work in July.—During the month of July, 1917, the British Air Services (Royal Flying Corps and Royal Naval Air Service) on the Western front brought down 122 German airplanes and drove down 120 machines out of control. In all, 1,940 enemy batteries were located; it enabled the artillery to destroy 345 battery emplacements; 973 were hit and damaged, and 935 explosions were caused in the enemy's lines.

Death of James Valentine.—The death of Maj. James Valentine, R.F.C., is reported from Kieff, Russia, as the result of wounds received in action with an enemy airplane. Major Valentine was attached to the Russian Air Service in an organizing capacity, with the rank of lieutenant-colonel.

James Valentine was one of the few English sportsmen, who had taken up aviation as a pastime prior to the outbreak of the war. He obtained his pilot certificate in 1910, at Brooklands, on the Macfie biplane, which was one of the first English-built machines, and soon developed into a brilliant aviator. Valentine achieved particular prominence in the European Circuit, in July, 1911, and in the *Daily Mail* Circuit of Great Britain, where he secured third place, being the only English pilot to complete the course within the prescribed time. In 1912 he acted as pilot of the British and Colonial Aeroplane Co. (Bristol) in the British Military Trials at Salisbury Plains. Subsequently, he participated in several great races, notably the Aerial Derby, until the war, when he joined the Royal Flying Corps.

With the rank of captain he was sent to Paris, where his services won for him the Cross of the Legion of Honor. He was subsequently transferred to the Russian front, which he reached partly by the air route, one assumes, by flying from Salonica to Bucharest. While on the Russian front the Distinguished Service Order was bestowed upon him.

Major Valentine was one of the most popular figures in the world of aviation and all old-timers will deeply mourn his untimely departure.

The Growth of the Acetylene Welding Industry, by a correspondent.

General Remarks Relating to Autogenous Welding, etc., by G. Wüthrich, M.I.E.E.

Scientific Welding.

High-Pressure System of Oxy-Acetylene Welding.

Oxy-Acetylene Welding Equipment.

A series of articles dealing exhaustively with the principle of autogenous welding, and the equipment and operation thereof.

Espana Automovil (Madrid), July 30, 1917

An Aviation School at Barcelona.—An aviation school has recently been organized, through the efforts of the Aero Club of Cataluña, near Barcelona. D. Salvador Hedilla, a Spanish aviator, is chief pilot of the school. The other instructors are Domingo Rosillo, the Cuban aviator, Francisco Coterillo and Valentin Diaz, the two latter being Spaniards.

for use in the construction of aircraft must break at no less than the amount specified in the attached table.

At least one bending test is to be made on a sample cut from each 50,000 ft. of cable of a given size. Each sample must be bent once around its own diameter and straightened again at least 20 times in succession in the same direction of bending without any of the wires breaking.

A torsion test is to be made on one wire from each sample of cable taken for tensile test. The wire is to be gripped by

AIRCRAFT GALVANIZED MULTIPLE CABLE *7x7 WIRE CENTER (Flexible)

Diameter of Cable, in.	Breaking Strength of Cable, lb.	Approximate Weight lb. per 100 ft.
3/16	9,200	16.70
1/4	5,800	10.50
7/32	4,600	8.30
5/16	3,200	5.80
11/32	2,600	4.67
3/8	1,350	2.45
13/32	970	1.75
7/16	920	1.45
15/32	550	0.93
1/2	480	0.81

* Seven strands of seven wires each.

AIRCRAFT TINNED MULTIPLE STRAND CABLE *7x19 WIRE CENTER (Extra Flexible)

Diameter of Cable, in.	Breaking Strength of Cable, lb.	Approximate Weight lb. per 100 ft.
3/16	14,400	26.45
11/64	12,500	22.53
5/32	9,800	17.71
9/64	8,000	14.56
1/4	7,000	12.00
11/64	5,600	9.50
3/16	4,200	6.47
5/32	2,800	4.44
1/8	2,000	2.88

* Seven strands of nineteen wires each.

two vises 4 in. apart; one vise shall be turned uniformly at as high a rate of speed as possible without perceptibly heating the wire. One vise shall have free axial movement in either direction. The number, N, of whole turns through which the wire must stand twisting is given by the formula:

$$N = \frac{1.1}{d}$$

where d equals the diameter of the wire in inches. Failure of one piece of wire to show full number of turns specified in the above torsion test shall not be considered cause for rejection, but in each case two additional tests shall be made on two more wires from the same sample of cable and if both samples meet the requirements of the specifications the strand shall be accepted in this respect.

No variation is permissible below nominal diameter. Cable having a diameter of 1/32 to 5/32 in. inclusive shall have a permissible variation of 10 per cent. above size and cable having a diameter of 3/6 to 3/8 in. inclusive shall have a permissible variation of 7 per cent above size.

Protective Coatings for Metals

The Aeronautic Division of the Standards Committee of the S. A. E. is now engaged in a study of the various kinds of anti-rust treatment of metals. This subject is exceedingly important at present, on account of the need for protecting many of the bolts, nuts and fittings used on aircraft from the action of the elements. It is planned to secure as many samples as possible of treatments making use of chemical or heat methods or a combination of the two, for protecting metals.

The Boyce Motometer

The Boyce Distance Type Motometer consists essentially of three main parts: the temperature responsive element or bulb, the flexible copper tubing which connects the bulb to the third part, the recording instrument.

The advantages of this instrument over the familiar Boyce motometer, so commonly seen on automobile radiators, are two-fold. In the first place, the temperature responsive element is located in the circulating water, and the temperature indicated on the registering dial is the actual temperature of

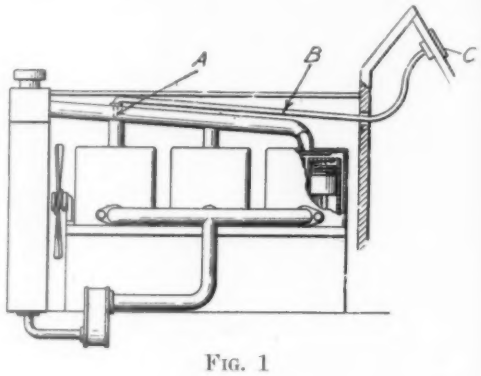


FIG. 1

the water, and not the temperature of the air above the water in the radiator, as is the case with the older type. Secondly, the indicating dial and mechanism can be placed on the dash of the automobile or on the instrument board of the airplane. This makes it far more convenient to read, and at the same time places the indicating mechanism in a position where there is less vibration from the engine.

The temperature responsive element is nothing more than a hollow bulb filled with an expansible fluid. This bulb is located in the cooling system, preferably in such a place as to be influenced by the cooling water after it has attained its highest temperature, and where it will be subject to the action of any steam which may form in the jackets.

The bulb is connected with the flexible hollow tube, which is also filled with the expansible fluid. The other end of the tube is carried to the instrument board, where it connects with the registering instrument. This part of the instrument com-

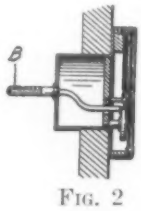


FIG. 2

FIG. 3

prises a Bourbon tube, with the exterior of which the bore of the flexible tube communicates, the free end of the Bourbon tube being connected by a suitable mechanism to the indicating number. Any increase in temperature of cooling water will cause the fluid in the bulb to expand, the pressure in the Bourbon tube will increase, and, in accordance with a well-known principle, it will tend to straighten out and bring the recording hand into play by a system of levers. Conversely, a cooling of the water will cause the fluid in the bulb to contract, thus relieving pressure in the Bourbon tube and permitting recording hand to return to its initial position. Any suitable temperature scale may be employed.

In Fig. 1, the responsive bulb is shown located at *A*, with the flexible tube *B* leading to the Bourbon tube at *C*. Figs. 2 and 3 illustrate diagramatically the construction of the Bourbon tube and of the recorder.

New Aluminum Production Method

A method has recently been patented in this country for obtaining aluminum from aluminum carbide. The latter is mixed with 10 to 20 per cent, by weight, of oxide, chloride and sulphide of aluminum, and the charge is then reduced in a vertical electric furnace at 2100 to 2200 deg. C. under a pressure of 10 to 15 lb. per sq. in. above atmospheric. When alloys are required, oxide, chloride, or sulphide of the respective metal is added in such proportion as to obtain a neutectic alloy. In the case of copper, for instance, the proportions would be copper 5.8 per cent and aluminum 94.2 per cent.

Digest of the Foreign Aeronautical Press

Aeronautics (London), August 9, 1917

Aircraft Losses in July.—Our Air Service overseas had three famous days last month. The first was July 11, when our aerial activity seems to have borne no special relation to operations in the field. At any rate, our men destroyed fourteen German machines and drove down sixteen out of control, while another was shot down by gunfire from the ground. Again, as the inevitable prelude to battle nowadays, we got really busy before the third battle of Ypres. On July 28 we destroyed fifteen enemy machines and drove down sixteen out of control, and on the following day we crashed sixteen and caused another fourteen to spin down earthward. On these three days alone, therefore, we definitely accounted for 46 Germans, while the fate of 48 others is uncertain. Our loss for those three days was 25 machines missing, not all of which necessarily crashed or were brought down as the result of air fighting. The following are the complete figures of the month's losses on the Western front:

Destroyed by British in aerial combat, including four machines which fell in our lines and nine destroyed on returning from raids on England	131
Destroyed by British gunfire, including two in our lines	5
Destroyed by British trawler on East Coast	2
Destroyed by French in aerial combat	47
Destroyed by French gunfire	8
Destroyed by Belgians in aerial combat	6
Destroyed by Belgian artillery	2
Total German loss	201
Number driven down by British out of control, including one by anti-aircraft fire	127
Number driven down in enemy lines by French	54
Total	181
Total number of English machines missing	92
Total number of Allied machines claimed as destroyed by the enemy, including one French machine in Westphalia and two anti-aircraft victims	130

One word of caution. The term "driven down out of control" should not be taken too literally, for a spinning nose-dive is today one of the accepted battle maneuvres.

The American Air Service in France.—Evidence of the close cooperation between the American Air Service and that of the Allies, and of the earnestness of the effort about to be put forward by the United States—if it were needed—is afforded by the character and record of the men our latest Ally is sending over to prepare the way for her. On Aug. 2 Lieut.-Colonel Mitchell, director of the American Air Service in France, was the guest of honor at a reception given by the Aero Club of France in Paris, whereat he was presented with a silver medal. Speeches were made by the president of the club, M. d'Estournelles de Constant, the well-known Senator, and M. Daniel Vincent, Under-Secretary for Military Aeronautics. Lieut.-Colonel Mitchell possesses a fine record as a soldier, having been through the campaigns in Mexico, Cuba and the Philippines as a combatant, and the Russo-Japanese War as military attaché. He has passed the French tests as a fighting pilot and holds the Croix de Guerre awarded him for a noteworthy bombing raid over German territory.

Aeronautics (London), August 15, 1917

A Visit to a Bombing Group.—Hugues le Roux, aeronautical editor of the Paris Daily *Le Matin*, gives an interesting description of his visit to a French bombing "group," the latter unit being the equivalent of the American and English "wing" and consisting of three or more squadrons.

"By day bombs are released from a great altitude. This makes for inaccuracy of aim, but at the same time renders them more effective against the population of big cities, especially when the streets are crowded.

"Destruction raids are better carried out at night. They meet with practically no interference from the enemy, and can be effected from a height of 2,500 to 5,000 feet.

"Sometimes, pilots have told me, we come down as low as 1,500 feet over a railway station; this gives one the sensation of depositing the bomb with your hand, as it were. During the month of June our group dropped 3,700 lb. of bombs in daylight raids and 135 tons in night raids. When our men dropped 3,500 lb. of bombs on the railway and aerodrome of Chateled-sur-Retourue, the enemy admitted that close to $5,000,000 worth of munitions were destroyed in the fire which broke out.

"In short distance raids there is not much to choose between the French and the German, but in long distance raids the French are unquestionably superior. They carry them out almost daily. Treves (68 miles), Karlsruhe (109 miles), Ludwigshafen (124 miles), Coblentz (155 miles), Rottweil (93 miles), Essen (235 miles), Munich (217 miles), Stuttgart, Luxemburg, Dillingen, Sarrebruck are all within reach of their bombing squadrons.

"When questioned about the future, a pilot made the following reply, which is particularly interesting in view of America's air program: 'The aerial establishment attached to army corps (that is, reconnaissance and artillery airplanes) is now adequate. Fighting machines, both in quality and quantity, must be superior to those of the enemy. There lies their limit. But there are no limits to the expansion of the bombing branch of the service. There is no material obstacle in the way of our possessing 500,000 bombers one day. Landing grounds abound in Champagne in the sectors of Noyon and Soissons, and this, our dream, we present to our new Allies over the water.'"

Aeronautics (London), August 22, 1917

The British Air Service Work in July.—During the month of July, 1917, the British Air Services (Royal Flying Corps and Royal Naval Air Service) on the Western front brought down 122 German airplanes and drove down 120 machines out of control. In all, 1,940 enemy batteries were located; it enabled the artillery to destroy 345 battery emplacements; 973 were hit and damaged, and 935 explosions were caused in the enemy's lines.

Death of James Valentine.—The death of Maj. James Valentine, R.F.C., is reported from Kieff, Russia, as the result of wounds received in action with an enemy airplane. Major Valentine was attached to the Russian Air Service in an organizing capacity, with the rank of lieutenant-colonel.

James Valentine was one of the few English sportsmen, who had taken up aviation as a pastime prior to the outbreak of the war. He obtained his pilot certificate in 1910, at Brooklands, on the Macfie biplane, which was one of the first English-built machines, and soon developed into a brilliant aviator. Valentine achieved particular prominence in the European Circuit, in July, 1911, and in the *Daily Mail* Circuit of Great Britain, where he secured third place, being the only English pilot to complete the course within the prescribed time. In 1912 he acted as pilot of the British and Colonial Aeroplane Co. (Bristol) in the British Military Trials at Salisbury Plains. Subsequently, he participated in several great races, notably the Aerial Derby, until the war, when he joined the Royal Flying Corps.

With the rank of captain he was sent to Paris, where his services won for him the Cross of the Legion of Honor. He was subsequently transferred to the Russian front, which he reached partly by the air route, one assumes, by flying from Salonica to Bucharest. While on the Russian front the Distinguished Service Order was bestowed upon him.

Major Valentine was one of the most popular figures in the world of aviation and all old-timers will deeply mourn his untimely departure.

The Growth of the Acetylene Welding Industry, by a correspondent.

General Remarks Relating to Autogenous Welding, etc., by G. Wüthrich, M.I.E.E.

Scientific Welding.

High-Pressure System of Oxy-Acetylene Welding.

Oxy-Acetylene Welding Equipment.

A series of articles dealing exhaustively with the principle of autogenous welding, and the equipment and operation thereof.

Espana Automovil (Madrid), July 30, 1917

An Aviation School at Barcelona.—An aviation school has recently been organized, through the efforts of the Aero Club of Cataluña, near Barcelona. D. Salvador Hedilla, a Spanish aviator, is chief pilot of the school. The other instructors are Domingo Rosillo, the Cuban aviator, Francisco Coterillo and Valentin Diaz, the two latter being Spaniards.

The flying equipment comprises two Blériot Penguins, fitted with 45 hp. Labor-Aviation engines, used for ground work; one 45 hp. Hedilla-Anzani monoplane; two Vendôme-Le Rhône 50 hp. monoplanes and two Hedilla-Le Rhône 80 hp. monocoques. A Gnome 50 hp. Morane-Saulnier monoplane, which belongs to one of the pilots, is also kept at the school.

Flight (London), August 16, 1917

Standardization of Parts.—An international committee to standardize the metal parts of aircraft is now sitting in New York, and the result of its labors is expected to be that these parts will be reduced to a few standard shapes, thus facilitating aircraft production on an enormous scale for the use of the Allies. On the face of it, this is an excellent thing, but we trust it will not be overdone. The international committee will do well to keep it in mind that aircraft design is progressing almost from day to day, and that the best machine of today is hopelessly inferior to that of tomorrow.

Undoubtedly, there are many metal parts and fittings of aircraft, which can be very usefully standardized, but, on the other hand, it is possible to overdo the manufacture of standardized parts that there would be serious danger of machines being turned out after they had become obsolete merely because contracts for particular designs had been placed on a basis of stocks of parts. We have suffered from the same sort of thing here, as we have had to point out in the columns of *Flight* more than once, though not so much from over-standardization as from want of prevision.

The main trouble seems to be that when parts have been ordered in large quantities and contracts placed for the resultant machines, no one cares to take the responsibility of ruthlessly scrapping an obsolete design. That is the case in businesses which have adopted the manufacture of the standardized article. We see it in the case of the cheap American car, which, although it may be a good enough production for the work it has to do, nevertheless lags hopelessly behind the practice of the day. In that case, its want of up-to-dateness, if we may call it that, does not matter because it does not claim to be the best, nor does its work demand that it should necessarily be the best.

The fact remains, however, that the first object of its manufacturers is a huge output before everything. That can only be attained through absolute standardization of parts, which carries with it the disability that standardization carries to an extreme is of necessity the sworn enemy of progress.

Standardization is very much like business "systems." It is an excellent thing so long as it is kept in subjection and made to serve the interests of its masters. Put it in the position of master instead of servant and it becomes a drag on the wheels. We are by no means against the work of the international committee.

On the contrary, if it is kept within reasonable limits we can well see that it will assist materially in the acceleration of the production of aircraft for the purposes of the war, but we think it is as well to utter a warning lest it should strive for over-standardization and thus actually retard instead of helping along the acceleration of production, so far as the best and most up-to-date types are concerned.

Flight (London), August 23, 1917

A New Aluminum Alloy.—In the endeavor to find an alloy combining lightness with strength, many metals have been tried in combination with aluminum. The merit of originality can certainly be claimed for the latest project, for it is claimed that by combining about 8 to 10 per cent of calcium, an alloy is obtained which is 5 to 20 per cent lighter than aluminum and possesses machining properties superior to aluminum or any of its other alloys.

It is suggested as being suitable for light castings such as airplane fittings, possessing the advantages of low specific gravity, the best machining properties it is possible to obtain and freedom from brittleness, while it should be capable of taking the finest impressions from the mold.

It would appear that the calcium acts as a flux and a detergent or purifier, converting the aluminum into a true homogenous metal with the qualities that go therewith, and preventing the formation of oxide while the original metal or the subsequent castings are being made.

Naturally this alloy cannot be made by simple fusion of the mixed metals because the calcium itself burns, even when heated at a low temperature. To make the alloy, calcium in small pieces is pushed under the surface of the melted aluminum and held there until melted.

Flying (London), August 15, 1917

Aero Engine Induction, by Vincent Clarke, A.M.I.C.E., M. I.M.E., being a summary of the problems confronting the operation of carburetors employed on aero-engines. The following quotation is of particularly pertinent importance at the moment when the fighting level of pursuit airplanes is being daily carried higher and higher:

"From the pilot's point of view there is still room for a great deal of improvement in the supply of gasoline to the carburetor itself when the aircraft is rising rapidly or stalling, and the problem of carburetion is increasingly difficult in the case of military aircraft, which have to be varied in all manner of directions owing to the maneuvering necessary while fighting.

"This has taken place at altitudes of over 20,000 feet, so it is quite apparent that the problem of altitude has been to a considerable extent thrust upon the attention of the designer and the manufacturer of these engines. Probably, at present, the influence of altitude is one of the most important considerations regarding carburetion, and in dealing with this the advantages of forced induction become apparent.

"It is possible that great alterations in design may be made, and interconnected with the problem of carburetion is the question of compression at these high altitudes: therefore both factors have to be taken into account. Engines having a compression ratio as high as six to one are running satisfactorily at sea-level today, but this has been rendered possible only by evolving such a combination of features as valves of suitable design, diameters, and openings, and by going into the matter of cylinder head design very scientifically.

"Incidentally, it may be mentioned that together with this notable increase in the economy and compression ratios there has been a considerable increase in the mean effective pressure, and measured from the brake horsepower a mean effective pressure of as much as 134 lb. per square inch has been obtained from the latest designs of engines."

Aeronautical Journal (London), April-June, 1917

Methods of Measuring Aircraft Performances, by Capt. H. T. Tizard, R.F.C.

The Screw Propeller in Air, by M. A. S. Riach, A.F., A.E.S.

The High Tension Magneto, with Special Reference to the Ignition of Airplane Engines, by A. P. Young, A.M.I.E.E., A.I.E.E.

Another series of the excellent lectures on aeronautical subjects, for which the Aeronautical Society of Great Britain has more recently received just fame. These lectures are of such a wholesome nature that no abstract would render them full justice.

The Aeroplane (London), August 8, 1917

The Production of Aeroplanes and Their Components. Eighth installment. By Stepney Blakeney.

Aero-Motors in Kind and Construction, by Geoffrey de Holden-Stone.

The Case of Autogenous Welding, by Artifex.

The Aeroplane (London), August 15, 1917

Aero-Motors in Kind and Construction. By Geoffrey de Holden-Stone.—A comparative study of two well-known French rotary engines, the Le Rhone and the Clerget.

The Le Rhone discussed is the 9-cylinder, 110 h.p. model, with a bore of 105 mm. and a stroke of 140 mm. The Clerget 130 h.p. model, also a 9-cylinder type, has a bore of 120 mm. and a stroke of 150 mm. Both engines are also produced as a 7-cylinder model, with the identical cylinders as the above; the smaller Le Rhone develops 85 h.p., and the Clerget 90 h.p.

The weight of the 7-cylinder Clerget is 234 lb. and that of the 9-cylinder model 395 lb.

A clear description is given of the valve-gear systems used. On the Le Rhône, the cam-plate is mounted concentrically to the shaft axis, while the Clerget is fitted with a star-cam, which is mounted excentrically on the crankshaft.

The Production of Aeroplanes and their Components. By Stepney Blakeney. (Ninth instalment.)

News of the Fortnight

Legal Status for Aircraft Board

The Sheppard bill giving a legal status to the Aircraft Board, having charge of the $640,000,000 aircraft program, was passed in the Senate on September 12. The board, if the bill becomes a law, will consist of the Chief Signal Officer of the Army, the Chief Constructor of the Navy, and seven civilian members who will receive salaries of $7,500 each. No contracts can be made by the board without the approval of the War and Navy Departments.

French Air Services United

An official decree published in Paris on August 18 announces the fusion of the French Army and Navy Air Services under the single direction of the Sub-Secretary of State for Aeronautics. The latter, who is directly responsible to the French Parliament, has hitherto been only in charge of the Army Air Service, the Navy Air Service having been under orders of the Minister of Marine. The position of Sub-Secretary of State for Aeronautics is at present filled by M. J. Dumesnil.

The decree also emphasizes that the French Air Services will act in close cooperation with the air services of the Allies.

H. B. Oakleaf Called to Capital

Howard B. Oakleaf, head of the department of lumber research in the U. S. district forest office at Portland, Ore., has gone to Washington, D. C., under orders to report as adviser in the purchase and inspection of wood materials for aircraft.

Mr. Oakleaf is well known to western lumber dealers. He took forestry work at Yale in 1906 and was graduated from the Baltimore forest school in Asheville, N. C., in 1908. He entered the United States forest service the same year at Washington, D. C.

$30,000 for Torpedoplane

Godfrey L. Cabot, president of the Aero Club of New England and a vice-president of the Aero Club of America, has put $30,000 at the disposal of Rear Admiral Bradley A. Fiske, U. S. N., retired, the inventor of the torpedoplane, for the development of a craft capable of carrying and launching a full-sized torpedo, the weight of which is 2000 pounds.

In announcing his gift Mr. Cabot said he was convinced the torpedoplane offered the only apparent means of destroying the German fleet, which, in Kiel and Wilhelmshaven, is protected from attack by other war vessels, rows of mines and shore batteries. Mr. Cabot intimated also that if $30,000 were not enough for the purpose he would enlarge his contribution.

Corporation Takes Over Factory

The Grant Hammond Manufacturing Corp. has taken over and is operating the drop forging and machine plant formerly operated by M. Seward & Sons Co. and the Maxim Munitions Corp. at New Haven, Conn.

New Company to Make Airplane Engines

Henry M. Leland and Wilfred C. Leland, who recently resigned as president and general manager of the Cadillac Motor Car Co., Detroit, Mich., have completed the organization of a $1,500,000 company.

The concern has been incorporated as the Lincoln Motor Co. and has a factory composed of buildings formerly occupied by the Rands Mfg. Co. One hundred men are now at work and it is announced that 2000 will be employed soon. An output of 20 airplane engines per day is planned.

New Wright-Martin Officials

S. H. Humphrey has been appointed general manager of the Wright-Martin Aircraft Corp., New Brunswick, N. J. Mr. Humphrey formerly was manufacturing manager of Chalmers, and later of Briscoe & Hupp.

John R. Cautley, who has been for some time engineer for Peter A. Frasse & Co., New York City, has joined the engineering forces of the Wright-Martin Aircraft Corp. He is making his headquarters in Washington, D. C.

More Funds for Naval Aviation

The Urgency Deficiency bill, which was committed to the Committee of the Whole House and ordered to be printed on September 6, provides among other things for the Navy, a fund of $35,000,000 for aviation.

This amount is "to be expended under the direction of the Secretary of the Navy for procuring, producing, constructing, operating, preserving, storing and handling aircraft; maintenance of aircraft stations; and for experimental work in the development of aviation for naval purposes; Provided, That the sum to be paid out of this appropriation under the direction of the Secretary of the Navy for drafting, clerical, inspection and messenger service for aircraft stations shall not exceed $175,000."

The bill provides, in addition to numerous other appropriations, a portion of $3,000,000 for "war balloons and airships and accessories, including their maintenance and repair," at the Panama Canal.

Col. Roosevelt Flies with "Liberty" Engine

Col. Theodore Roosevelt recently had a flight in an airplane fitted with the new "Liberty" engine at Mineola.

The Colonel rode in the observation seat of an L. W. F. biplane, driven by H. W. Blakely. Most of the flight was at a height of between 5000 and 6000 feet.

C. L. Taylor Joins Aircraft Company

The announcement is made that Charles L. Taylor, president of the Carnegie Fund Hero Commission, with associates, has become affiliated with the Loughead Aircraft Manufacturing Co. of Santa Barbara, Cal.

A Santa Barbara site for a large plant, the only one in the West, has been secured, and it is said that within ninety days the concern will be able to make deliveries of various types of planes for war duty.

Swedish-German Air Route Planned

A committee has been formed in Stockholm with a view of establishing a regular airplane route between Trelleborg, in southern Sweden, and Sassnitz, Germany. It is asserted that a Swedish banker has offered 4,000,000 kroner ($1,000,000) for financing the enterprise.

The existing ferryboat service between Trelleborg and Sassnitz, besides being slow, is often interfered with by floating mines and allied submarines. An airplane service would therefore furnish both a quicker and much safer means of transportation than is at present available.

Aviators Leave Huntington, L. I.

Flying has stopped at the Huntington seaplane camp on Huntington Harbor, L. I., and the men, as well as the equipment, are being redistributed at other bases.

To Train Aviators in New York State

The bill to make the practice in acquiring land in New York State for Federal aviation fields, the same as the law covering the taking of land for fortifications, was signed September 11 by Governor Whitman. The act will take effect immediately.

At the request of Secretary of War Baker and under an emergency message from Governor Whitman of New York State, a bill was received by the New York Legislature Sept. 5 to make the practice in acquiring land in the State for Government Aviation Fields the same as the law governing the taking of land for fortifications. Immediate passage of the bill was asked so that there might be as little delay as possible in the acquisition by the Government of property to be used for aviation purposes.

Secretary Baker said that it was "probable that the United States Government in the near future will find it necessary to purchase some tracts of land in New York State for various purposes, particularly for the establishment of flying fields for the aviation service."

Cuban Aero Squadron for France

Colonel Coronado, a member of the Cuban Senate, is organizing an airplane squadrilla which will be offered, completely equipped, to the French Republic. This *Escadrille Cubaine*, as the unit is officially called, will be Cuba's first contribution of fighting men to the Allied cause.

Colonel Coronado's plans called for a body of twenty-five trained aviators to comprise the escadrille, but already thirty-three youths, who are representatives of the best families of Cuba, have volunteered to take the prescribed aviation course and individually to bear the expense of their airplanes and equipment. Many of the volunteers for the escadrille are graduates of French universities, and all speak French and are aviation enthusiasts. Senator Coronado has just returned from New York where he conferred with officials.

The colonel has asked the Navy Department in Washington for an arrangement by which the Cuban aviators may undergo their preliminary training at the navy aviation school at Pensacola, Fla.

Resnati Makes New Air Record

Captain Resnati of the Italian Army, a member of the flying corps instructing American aviators at Norfolk, Va., remained in the air for six hours on September 13 in a Caproni triplane which carried ten passengers, establishing a new record for a continuous flight with passengers.

He left the earth at 12.30 in the afternoon and returned at 6.30 o'clock. He flew over all the Virginia peninsula almost out to the Virginia Capes and far back into the country.

New World's Distance Record

Capt. Giulio Laureami, of the Italian Army Air Service, established, on August 29, a new world's distance record for airplanes by flying from Turin to Naples and back without a stop, a distance of 1,472 kilometers (920 statute miles) in air-line.

Captain Laureami used a new airplane, built by the Società Italiana Aeroplani of Turin and fitted with a Fiat engine. He left Turin at 10.07 a. m., reached Naples at 12.30 p. m., and was back in Turin at 8.40 p. m.

The previous world's distance record was established by Lieut. Antoine Marchal, of the French Army Flying Corps. In June, 1916, Marchal flew from Nancy, France, to near Cholm, Russian Poland, in a Nieuport biplane. This distance covered was about 807 miles. During the flight Lieut. Marchal dropped proclamations on Berlin. He was made prisoner by the Austrians at Cholm and was interned at Salzerbach.

The next best distance record was held by Second Lieut. Michel Draguseanu of the Roumanian Army Flying Corps, who flew on July 21, 1917, from Salonica to Kulmskaia (Bessarabia), a distance of nearly 1000 kilometers (625 miles). During his flight, which carried him over Bulgaria and Roumania, Draguseanu dropped proclamations on Bucharest and Constanza, and had several combats with enemy airplanes, two of which he shot down.

The American long-distance, non-stop record is held by Miss Ruth Law, who flew 590 miles from Chicago to Hornell, N. Y., on Nov. 19, 1916. Her elapsed time was 5 hours and 45 minutes.

Accept U. S. Buying Commission Agreement

Secretary McAdoo announces that formal agreements have been signed by the Secretary of the Treasury, with the approval of the President, on behalf of the United States, and by the Ambassador of Italy and the Ministers of Belgium and Serbia providing that all purchases by these Governments in the United States shall be made through the recently created commission composed of Bernard M. Baruch, Robert S. Lovett and Robert S. Brookings.

Similar agreements previously were signed with representatives of Great Britain, France and Russia.

The members of the commission are also members of the recently created War Industries Board of the Council of National Defense, and will thereby be able to thoroughly coordinate the purchases of the United States Government with the purchases of the Allied Powers.

R. B. Maxwell with American Propeller

Mr. R. B. Maxwell, assistant curator of the section of wood technology, National Museum, has resigned to accept a position as chief inspector with the American Propeller & Manufacturing Co. of Baltimore, Md.

Permits Americans to Keep War Medals

Senator Lodge's bill to permit Americans to retain decorations received from Allied Governments for military service when they enter the American army was passed September 12 by the Senate and has gone to the House. The present law forbids such decorations on American soldiers.

Many Americans who have been decorated for valor want to join their country's forces, but hesitate to give up the marks of bravery they have won. Among these are members of the Lafayette Escadrille, the flying corps of Americans attached to the French army.

Army Flying School at Fort Worth

The Signal Corps has made arrangements to establish a flying school at Fort Worth, Tex., where English instructors will assist American officers in preparing American flyers for air service on the Western front.

American student flyers are already under training in the Royal Flying School at Toronto, Canada. During the winter conditions are less favorable for flights in Canada, so about November 1 the instructors, students, and some of the equipment will be transferred to the Fort Worth school, a name for which has not yet been adopted. It is expected that by that date a sufficient portion of the barracks, machine shops, class rooms, hangars, etc., will be completed to provide for the opening of the school.

Four squadrons—600 men—will probably be under training in the new school when completed. Some of these will be machinists necessary to keep planes and engines in proper condition. A large number of such men are required with every flying unit.

American and English instructors are considered by the Signal Corps an ideal combination. In teaching students to fly no country is acknowledged to have developed a better system than the United States, but in turning out men trained for actual fighting our instructors lack the actual experience of the English instructors.

The Fort Worth school will follow the practice pursued at other large schools of having several flying fields within flying distance of each other, but widely enough separated to give the student flyers plenty of room when in the air. It is roughly figured that a square mile is a good allowance for two squadrons whose flying equipment is 72 planes. Usually not more than 36 of those would be in the air at one time.

Bonus for Bay State Recruits

Lieut. Charles J. Glidden of the Aeronautical Division, Department of the Northeast, announces that Massachusetts will pay $10 a month in addition to the $100 salary to young men training as aviators and observation balloon pilots.

The training lasts six months. Then the flyers are commissioned first lieutenants at $2,000 a year.

Navy Airplane Factory Up with Rush

Work has been rushed to such good effect upon the new million-dollar airplane factory to be built at League Island, that parts of the concrete foundations and brick superstructure are already in place.

Day and night shifts of workmen are being used on the building.

Allied Aviators Here

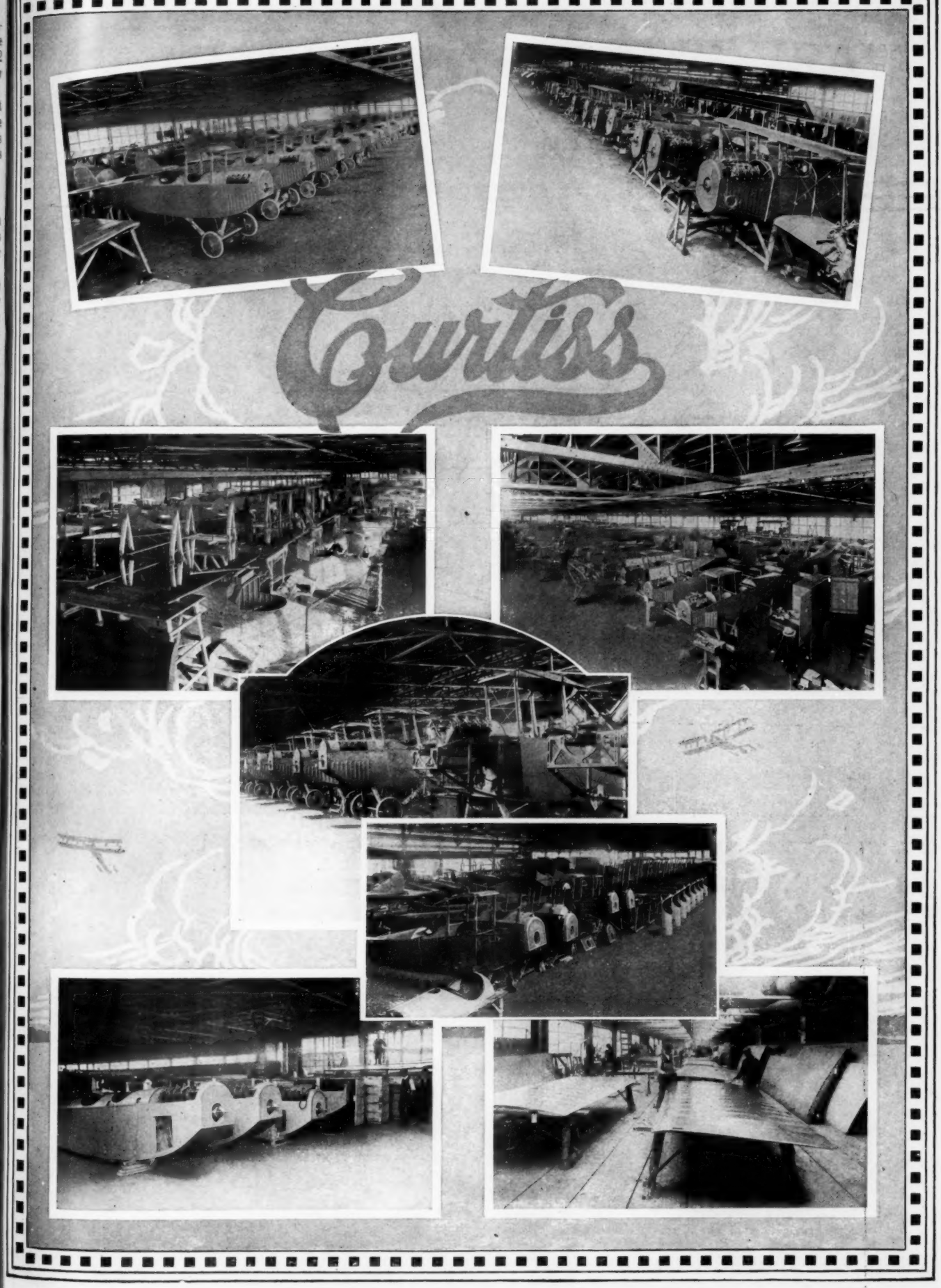
Eight Italian army officers, mostly from the aviation corps, arrived at an Atlantic port recently under command of Capt. Carlo Tappi. The object of their trip will be to purchase and inspect American airplanes and materials.

With the Italians were three more French aviation officers, who will serve as instructors to American airmen, and five officers of the United States Army who have been studying the needs of our forces in England and France.

Airplane Carries 25 Passengers

Captain Resnati, of the Royal Italian Flying Corps, established a new weight-carrying record for airplanes when, on September 14, he carried 24 passengers a distance of 50 miles in the neighborhood of Norfolk, Va.

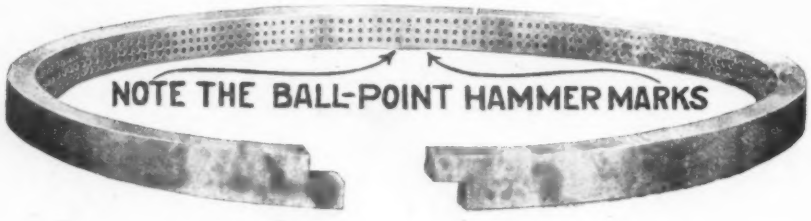
As soon as weather conditions permit, Captain Resnati's Caproni airplane will be flown from Old Point Comfort to New York, carrying at least twelve passengers. The maximum passenger-carrying capacity of the huge machine is twenty-four.



THE CURTISS AEROPLANE COMPANY, BUFFALO, N. Y.
Member Manufacturers' Aircraft Association, Inc.
America Trans Oceanic Company, 280 Madison Ave., New York City, New York Agents

AN AMERICAN VICTORY

American Hammered Piston Rings



American Hammered Piston Rings are recognized as the most mechanically perfect piston ring made to-day.

They are used exclusively as standard equipment by

WRIGHT-MARTIN
AEROMARINE
THOMAS MORSE

We have developed a new type of ring which is absolutely essential for an aeroplane motor. Send us blue prints of your piston and we will gladly forward full particulars.

American Hammered Piston Rings are also used exclusively by such builders of motor cars as

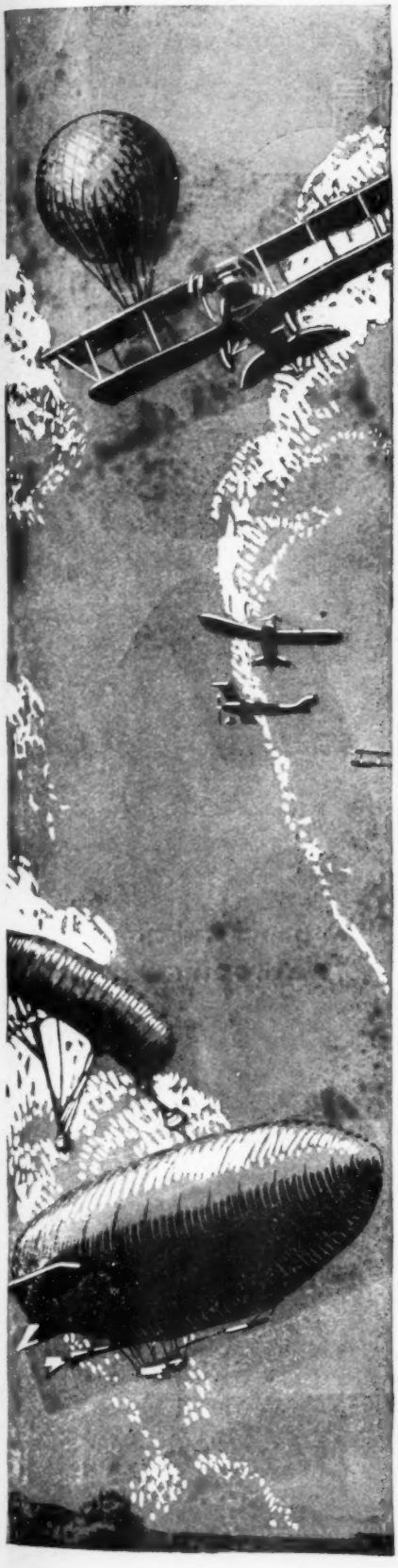
PIERCE ARROW	**WINTON**
MERCER	**CHALMERS**
STEARNS	**KELLY-SPRINGFIELD**
WHITE	**STEGEMAN**

And many others.

American Hammered Piston Rings are made of a special mixture of the finest gray iron and the tension is obtained by peening.

American Piston Rings They're Leak-Tight

AMERICAN PISTON RING CO.
FACTORIES---NEWARK, N. J.



The Goodyear Kite-Balloon

The kite-balloon perfected by Goodyear combines the principles of the man-lifting kite and the captive balloon.

The first was unpractical because it required a strong wind.

The second was unsatisfactory because its use was limited to periods of calm.

Neither was stable, nor free enough from veering and yawing.

The Goodyear type of kite-balloon has fused the operating principles of both, selecting the best in each, so that it serves in storm and calm and furnishes a fixed, unwavering eye for artillery and fleet.

The carefully adjusted inclination of the elongated bag makes the plane of its nether surface a kite when the wind is on its front, and a resistant plane when the air currents are heavy on the back of the bag.

The refinements of keel construction, steadying side fins, and stabilizing tail-cups are Goodyear contributions to steadiness in air.

Every factor necessary to the fusion of the principles of kite and balloon has been developed or perfected —either in design or in material, or both.

Everything in Rubber for Airplanes
Balloons of Any Size and Every Type

The Goodyear Tire & Rubber Company, Akron, Ohio

GOODYEAR
AKRON

AERUL
A practical quality oil
for aeroplane motors
SWAN & FINCH
AND
COMPANY
NEW YORK
Quality Oils and Greases Since 1853
¶ Distributor and jobber connections desired for sales to mills, factories, machine shops, foundries, railways, and automobile accessory and hardware dealers. Write for full particulars regarding territory, prices, etc. ¶ See Sept. 29 and Oct. 6 issues of the "Saturday Evening Post" for description of the Swan & Finch line of Atlas grease and oil specialties—*Aerul, Gearese, Motul, Slo-Flo, Textul, Talese, Asbestese, Corul, Cupese, Marinul.*

CRANKSHAFT QUALITY

Stands out as the one requirement today of the builder of

AIRCRAFT AND HIGH DUTY ENGINES

Experience only can produce a product to equal these demands.

Wyman-Gordon Company for many years, in their Research, as well as their Manufacturing Departments, have been developing along the lines that make them today able, without experiment, to supply crankshafts of

UNQUESTIONED RELIABILITY

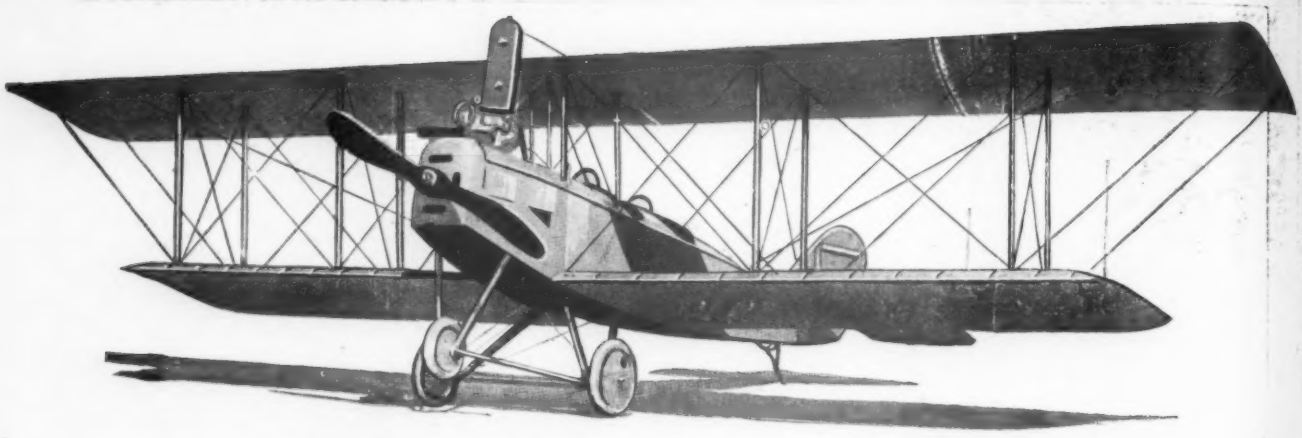
Every stage in the production of a Wyman-Gordon crankshaft is subjected to rigid inspection and tests guaranteeing a high metallurgical quality.

Behind this perfect product is a perfect service.

Prompt attention to all orders and deliveries without delay.

WYMAN-GORDON COMPANY

WORCESTER, MASS.



Airplane Parts!
Immediate Delivery!

Fortunately, the present crisis finds the Standard Parts Company ready to help you greatly in the rush demand for airplanes.

We are able to ship immediately necessary parts for the construction of airplanes the government must have in a hurry.

You can order from us at once such parts as:

Steel Tubing
Stabilizer Tubes
Push Rod Tubes
Tubing formed per B/P's and straight tubing in diameters ranging from ¼" to 2½", 14 gauge (.083") to 22 gauge (.028")

Special Rod Assemblies
Rims of all sizes to government specifications
Bearings
Tire Rims
Springs
Forgings.

For years we have made oval and "D" shaped tubing for the Curtiss Airplane Co.

Let us help you make your estimates.

Write us for information at once before you submit your bids for airplane construction.

If you have already made a contract, wire or write us immediately and take advantage of the instant service we can render you.

The factories of this company have been among the foremost in the field of motor-driven vehicles since the earliest days of the industry. Our engineering department and our laboratories are among the most complete in the world.

The Standard Parts Company, Cleveland, Ohio, U. S. A.

Famous for Stanweld Rims, Tubing, etc., Perfection Springs, Bock Bearings, Axles, Perfection Heaters, Forgings, Hubs, etc., etc.

Safeguarding the Airplane Motor

On the perfect performance of the motor depends the entire life of the airplane and its occupants.

¶ The use of the **BOYCE MOTO METER** gives to the pilot at all times an unfailing indication of the motor's condition. Its accuracy is absolute, its construction a masterpiece of scientific design.

¶ The Boyce Moto-Meter is standard equipment on 65 motor cars, trucks and airplanes.

¶ The great success of this motor heat indicator has been due to its extreme accuracy. Its action is unfailing.

¶ Such an instrument unless accurate, is worthless.

THE MOTO-METER CO., Inc.
Long Island City New York

J. ROBINSON HALL

AEROPLANES, MOTORS
AND EQUIPMENT

PACIFIC COAST
REPRESENTATIVE

FOREIGN AND AMERICAN
MANUFACTURERS

C. M. SOMMERVILLE
SALES MANAGER

609-611 Merritt Bldg., Los Angeles, California

Thomas

Contractors to U.S. Army and Navy

THOMAS-MORSE AIRCRAFT CORPORATION
ITHACA, N.Y. U.S.A.

Member Manufacturers Aircraft Association

American Walnut Propellers

To supply the increasing demand for our product the *Excelsior Propeller Company* has been forced to increase its facilities. We have reorganized our company under the new name of the

HARTZELL WALNUT PROPELLER CO.

and will occupy a modern three story factory at Piqua, Ohio, with 50,000 sq. ft. of floor space and all equipment necessary for the efficient manufacture of propellers in large quantities.
From now on our propellers will be produced from American Walnut, guaranteeing greatest *durability and best possible finish.*

With our new facilities we can give our customers prompt, efficient and satisfactory service.

HARTZELL WALNUT PROPELLER CO.
PIQUA, OHIO

ANNOUNCEMENT!

In view of the urgent requirements of the United States Government for

Resistal Aviator's Goggles

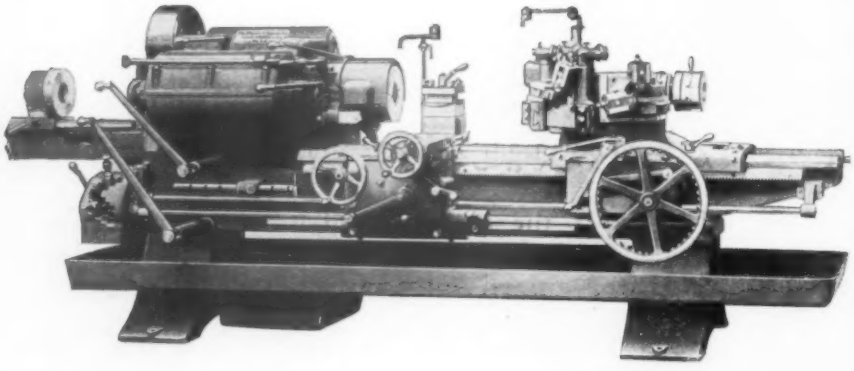
we are compelled to ask purchasers of RESISTAL AVIATOR'S GOGGLES to wait for shipments until we deliver to the Government.

Shortly after October 1, 1917, we will be in a position to ship orders for RESISTAL AVIATOR'S GOGGLES—just approved and standardized by the United States Signal Corps.

STRAUSS & BUEGELEISEN

37 Warren Street New York City

TO speed up the production of airplane motors, without in any degree slighting the accuracy that is so essential, install



Universal Hollow-Hexagon Turret Lathes

Even on the most exacting work these machines take two cuts at one time—face or undercut or form with the square turret on the carriage while the hollow-hexagon turret is boring or turning. Ask for Descriptive Literature.

THE WARNER & SWASEY COMPANY

CLEVELAND, OHIO, U. S. A.

TURRET LATHES—TURRET SCREW MACHINES—BRASS WORKING MACHINE TOOLS

NEW YORK Office—Singer Bldg. **Boston Office**—Oliver Bldg. **Buffalo Office**—Iroquois Bldg.
Detroit Office—Ford Bldg. **Chicago Office and Show Rooms**—618-622 Washington Blvd.

CRANKSHAFTS, Etc., Will Be Put in Running Balance in My Recently Organized

Laboratory *of* Dynamic Balance

Centrally Located in This City

All work guaranteed and done an my latest Balancing Apparatus. It appears that a great deal of misinformation is now being circulated with respect to the would-be *simplicity* with which, for instance, a six throw shaft can be balanced, by some self-appointed *experts*. Let me have a shaft balanced in this manner and I will explain the *correct* way of balancing such a shaft.

N. W. AKIMOFF, Builder *of* Dynamic Balancing Machinery

Office: HARRISON BUILDING, PHILADELPHIA

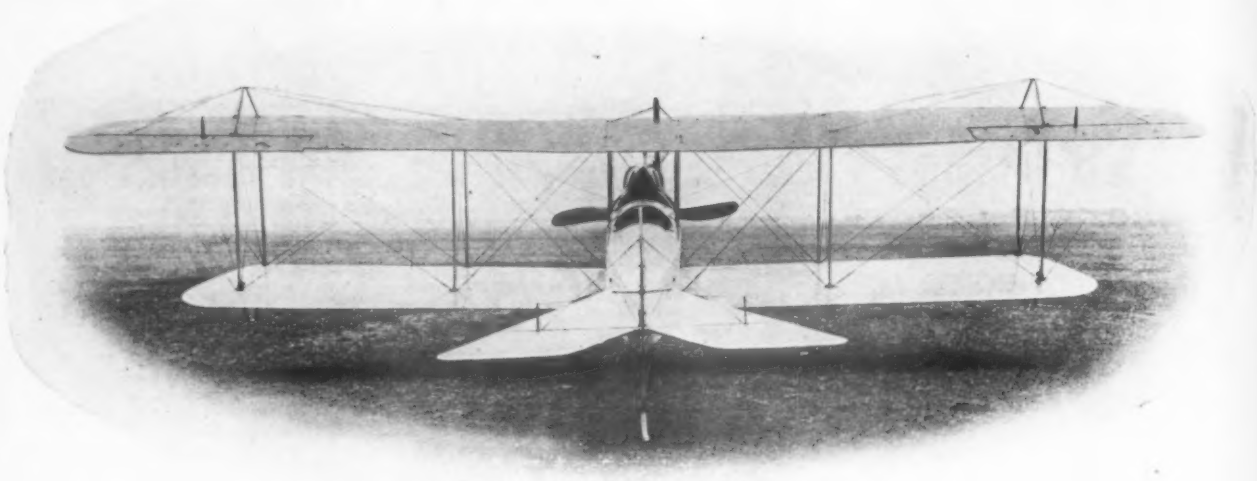
HYDROGEN GAS

Equipment for

AEROSTATION FIELDS

GAS ENGINEERING CO.

Trenton :: :: New Jersey



Model T. T., 90 h. p. Training Tractor

WITTEMANN-LEWIS AIRCRAFT COMPANY

Lincoln Highway
Near Passaic River

Newark, N. J.
Telephone Market 9096

WALDEN-HINNERS COMPANY

BUILDERS OF AIRCRAFT

MILITARY AIRPLANES
SEAPLANES
FLYING BOATS

OFFICE AND FACTORY
EDGEWATER, N. J.

Grand Rapids Lumber Tester

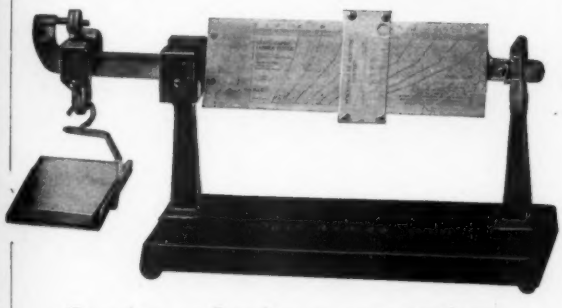
Test your lumber for moisture content:

I. When you buy it, to be sure you are getting what you want.

II. When you put in your kiln, to see how long it should dry.

III. When you empty your kiln, to insure properly dried lumber.

Don't guess at it. Guessing is a poor game.



Requires no figuring or computations. No charts or rollers to bother with.

Equally applicable to testing any material for moisture content.

Accurately made, graduated to metric system, and can be used for ordinary weighing.

GRAND RAPIDS VAPOR KILNS

Now used in aircraft work by:—

Curtiss Aeroplane & Motor Corp.
American Propeller & Mfg. Co.

Now building for:—

Fisher Body Corporation
Airplane Division

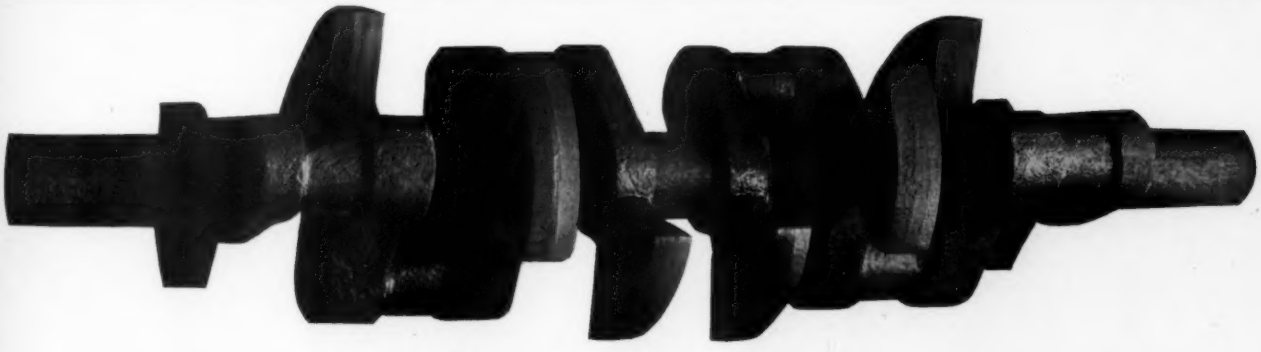
Equipment and instruments supplied to, in addition to above:—

Standard Aero Corporation
The Burgess Company
Thomas-Morse Aircraft Corp.
Dayton Wright Airplane Co.

GRAND RAPIDS VAPOR KILN

Made by GRAND RAPIDS VENEER WORKS

Grand Rapids, Mich. U. S. A. Seattle, Wash., U. S. A.



a counterbalanced aviation crankshaft . . . .

one of the 18 different
models we are now making
for 14 aviation motor companies . . .
reduces vibration and eliminates bearing pressure

We have shipped 50,392 Counterbalanced Crankshafts to August 28th, 1917

THE PARK DROP FORGE CO. CLEVELAND, OHIO

Emaillite

Licensed by and affiliated with Messrs. Leduc, Heitz & Co., Paris, France

AEROPLANE DOPE

of the

HIGHEST QUALITY

for

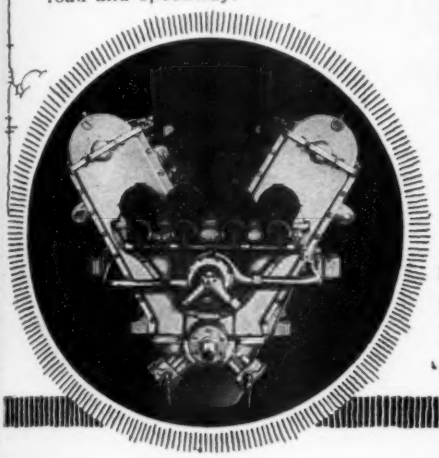
land and water machines built by constructors able to afford the best. Also gives excellent results and reduces fire risk when used for the last 2 or 3 coats over a cheaper dope

CONTRACTORS TO THE GOVERNMENT U.S.

AMERICAN EMAILLITE COMPANY
555 W. Washington Street
Chicago, Ill.

Wisconsin
CONSISTENT
AEROPLANE MOTORS

Give the aviator a motor in which he can place thorough confidence—that's the first requisite of successful flying. Wisconsin Aeroplane Motors are that kind—noted for consistent performance—absolutely dependable. The product of the same engineering skill that has made Wisconsin Racing Motors champions of the world on road and speedway.



Made in 6 and 12 cylinder sizes. Write for catalog with complete specifications.

WISCONSIN MOTOR MFG. CO.
Sta. A Dept. 338
Milwaukee, Wis.
New York Branch —21 Park Row— T. M. Fenner, Factory Rep.

IN ACTUAL DAILY PERFORMANCE

In every branch of military service—Engineering Corps, Aviation Section, Quartermaster Corps, and general Patrol, Scout, and Dispatch duty—you will find the 1917

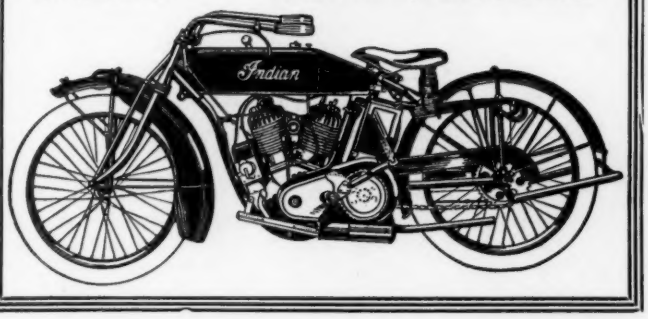
Indian Motocycle
With Powerplus Motor

Greatest strength, endurance, speed, power, accessibility, and all-round dependability.

We will be pleased to arrange demonstrations of all 1917 Indian models for interested military officials.

Illustrated 1917 Indian Catalog and other descriptive literature sent anywhere on request

HENDEE MANUFACTURING COMPANY
(Largest Motorcycle Manufacturers in the World)
859 STATE ST. SPRINGFIELD, MASSACHUSETTS



AIRPLANE
RIMS and WHEELS

Rims furnished punched for spokes and valve, ready to be built into wheels.

Wheels supplied less tires,—complete with all parts. Made to our own design or from manufacturer's Blue Prints.

Manufactured by the oldest and best known steel rim and wire wheel makers in America.

Careful experienced workmen and best grade of materials.

Quotations gladly submitted.

The MOTT WHEEL WORKS
Utica, N. Y.

Erie Specialty Co.
Main Plant
Erie, Pa.
Executive Offices: **25 Pine St., New York**
Manufacturers

AIRCRAFT METAL PARTS, BOLTS, NUTS, CLEVIS PINS, SHACKLES, EYE BOLTS, MACHINE SCREWS, ETC., ETC.

Fittings, Forgings, Castings

We are increasing our equipment in every department—foundry, forge shop, stamping, automatic screw machines, tool and die shop.

All our products are rigidly inspected and meet all Government requirements.

Are you on our catalog mailing list?

Emaillite

Licensed by and affiliated with Messrs. Leduc, Heitz & Co., Paris, France

AEROPLANE DOPE

of the

HIGHEST QUALITY

for

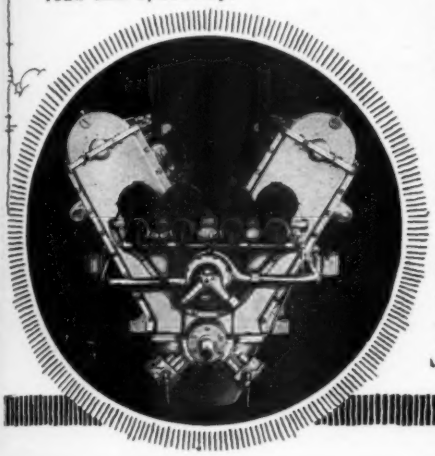
land and water machines built by constructors able to afford the best. Also gives excellent results and reduces fire risk when used for the last 2 or 3 coats over a cheaper dope

CONTRACTORS TO THE GOVERNMENT U.S.

AMERICAN EMAILLITE COMPANY
555 W. Washington Street
Chicago, Ill.

Wisconsin
CONSISTENT
AEROPLANE MOTORS

Give the aviator a motor in which he can place thorough confidence—that's the first requisite of successful flying. Wisconsin Aeroplane Motors are that kind—noted for consistent performance—absolutely dependable. The product of the same engineering skill that has made Wisconsin Racing Motors champions of the world on road and speedway.



Made in 6 and 12 cylinder sizes. Write for catalog with complete specifications.

WISCONSIN MOTOR MFG. CO.
Sta. A Dept. 338
Milwaukee, Wis.
New York Branch —21 Park Row— T. M. Fenner, Factory Rep.

IN ACTUAL DAILY PERFORMANCE

In every branch of military service—Engineering Corps, Aviation Section, Quartermaster Corps, and general Patrol, Scout, and Dispatch duty—you will find the 1917

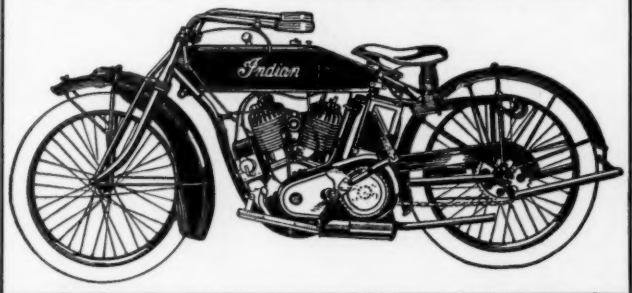
Indian Motocycle
With Powerplus Motor

Greatest strength, endurance, speed, power, accessibility, and all-round dependability.

We will be pleased to arrange demonstrations of all 1917 Indian models for interested military officials.

Illustrated 1917 Indian Catalog and other descriptive literature sent anywhere on request

HENDEE MANUFACTURING COMPANY
(Largest Motorcycle Manufacturers in the World)
859 STATE ST. SPRINGFIELD, MASSACHUSETTS



AIRPLANE RIMS and WHEELS

Rims furnished punched for spokes and valve, ready to be built into wheels.

Wheels supplied less tires,—complete with all parts. Made to our own design or from manufacturer's Blue Prints.

Manufactured by the oldest and best known steel rim and wire wheel makers in America.

Careful experienced workmen and best grade of materials.

Quotations gladly submitted.

The MOTT WHEEL WORKS
Utica, N. Y.

Erie Specialty Co.
Main Plant
Erie, Pa.
Executive Offices: **25 Pine St., New York**
Manufacturers

AIRCRAFT METAL PARTS, BOLTS, NUTS, CLEVIS PINS, SHACKLES, EYE BOLTS, MACHINE SCREWS, ETC., ETC.

Fittings, Forgings, Castings

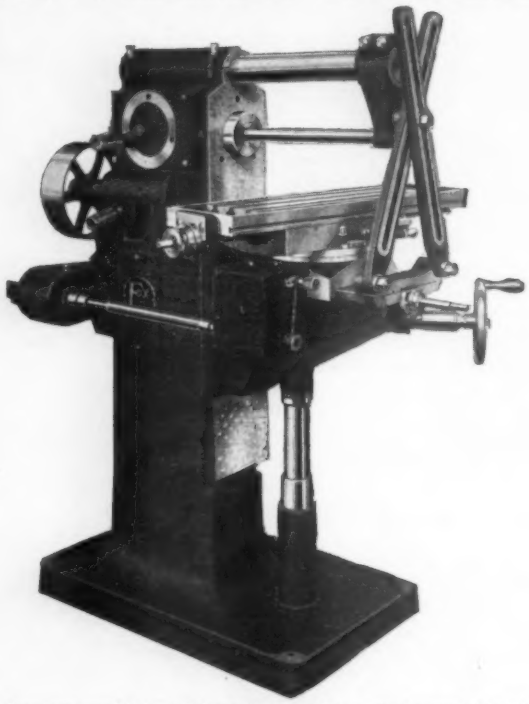
We are increasing our equipment in every department—foundry, forge shop, stamping, automatic screw machines, tool and die shop.

All our products are rigidly inspected and meet all Government requirements.

Are you on our catalog mailing list?

TRADE FOX MARK

UNIVERSAL MILLERS



Accurate machining of Aeroplane Engine parts demand this 2A Universal Miller. *Write for full particulars.*

FOX MACHINE CO., 1810 W. Canson Street JACKSON, MICH.

"THE TANDEM BIPLANE"

INHERENT LONGITUDINAL STABILITY

Richardson Aeroplane Corporation, Inc.
New Orleans, La.

ELJ-5

Officers of the Heavier-than-air Services of the United States and their Allies are invited to inspect the

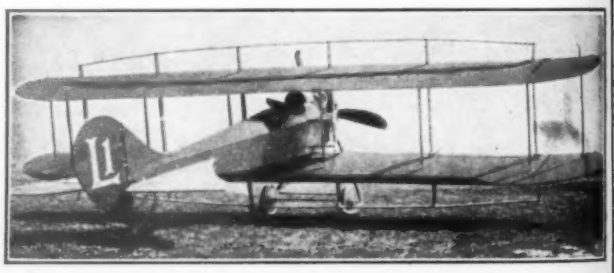
Janney Aircraft Company's

New Model Training Tractor Biplane ELJ-5

With Hall-Scott A-5 Six Cylinder Engine

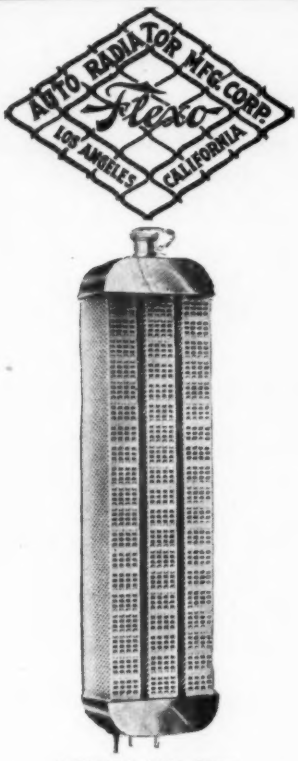
Detailed Description upon request

JANNEY AIRCRAFT CO.
MONROE, MICH.



With the manufacturing facilities of three large factories in New York, Tennessee and New Jersey we are in a position to execute with despatch orders for the LANZIUS CHANGEABLE ANGLE OF INCIDENCE AIRPLANE in any type for land or water, or for Standard and Special Design Aircraft, either wood or steel construction. We furnish with our standard equipment Duesenberg Motors, recognized as one of the most powerful and efficient Aeronautical Motors on the market.

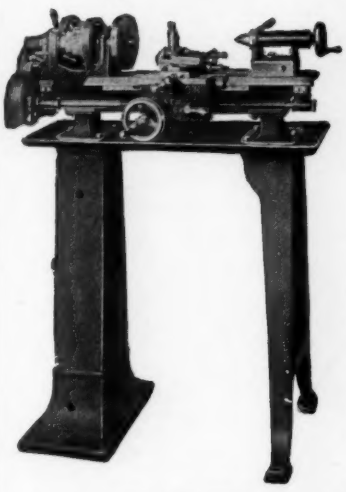
LANZIUS AIRCRAFT COMPANY
Executive Offices
608-609-610 Singer Building, 149 Broadway, New York
Telephones 6710-6711 Cortlandt



"Flexo" Side Type
Used by the U. S. Government
Having just completed large orders for the Allies we are in better position than ever to take care of our trade

AUTO RADIATOR MFG. CORP.
219-225 W. 12th STREET, LOS ANGELES, CAL.

"DALTON SIX"



In the Manufacture of Aeroplanes or the many small parts comprising a Unit

"Dalton Six"

is indispensable.

Furnished for English or Metric Thread Cutting.

One Manufacturer of fine instruments for aeroplanes now has

(36) "DALTON SIXES" Installed

Why Not Investigate?

BULLETIN B602C GIVES DETAILS

Dalton Manufacturing Corp.
Successors to Dalton Mach. Co., Inc.
1911 Park Avenue New York, U. S. A.

We Strive

To build the best radiator made. Maximum efficiency and minimum weight with stability.

We have never made a radiator to meet a price. Quality is the prime consideration.

Our ten years of manufacturing experience is at your disposal.

Samples submitted with quotations if you will mail your prints.

THE ENGLISH & MERSICK CO.
NEW HAVEN, CONN.

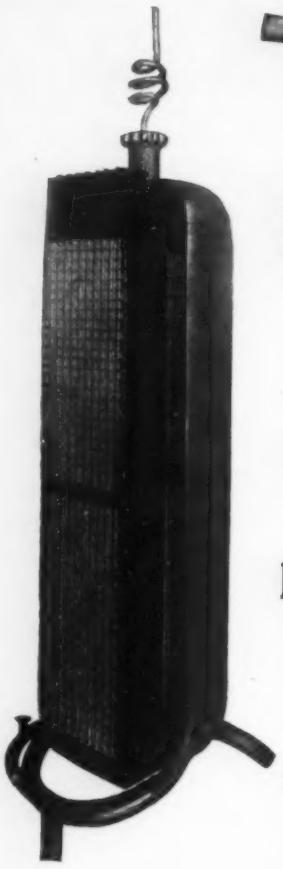
PROPELLERS

SPECIALLY designed and constructed to meet the requirements of your power plant.

Duplicate the propeller that gives you the best results. Send us your blades and we will duplicate them.

Inquiries Solicited

HARRIMAN AIRCRAFT MOTORS CO.
SOUTH GLASTONBURY, CONN.

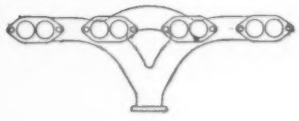


AJAX
Auto and Aero Sheet Metal Co.

Manufacturers and designers of

AERO RADIATORS INTAKE and EXHAUST PIPES

LINDER & MEYER
245 W. 55th St.
New York



Factors of Safety

These Count in Aeroplane Construction

NON-INFLAMMABLE

Cellulose Acetate Base

Celestron Cloth Varnishes

provide another SAFETY FACTOR

NON-INFLAMMABLE

Celestron Sheets AND Films

Transparent — Waterproof

MANUFACTURED BY

Chemical Products Company
93 Broad Street **Boston, U. S. A.**
Manufacturers of Cellulose Acetate for nearly 15 years

WESTMORE
PROPELLER

will not warp or split

Built for high power motors
Water proof and heat proof

Quantity Production

WRITE FOR INFORMATION

Address AIRCRAFT DEPARTMENT
SCHWEIZER & WEST MFG. CO.
308-324 N. Ada St., Chicago
Cable address "SWESCO"

Cabinet makers with over thirty years' successful business behind them

TURNBUCKLES

of the

Highest Quality

Bolts and Nuts

to Satisfy the Most Exacting Requirements

Standard Screw Co.

(of Pennsylvania)

CORRY, PA.

New York Office: Woolworth Building

CAPACITY QUALITY

DU PONT

WHERE LARGE PRODUCTION CONVERGES WITH THE MOST RIGID STANDARDS OF QUALITY AND EFFICIENCY

¶ Du Pont facilities and capacity can be depended upon to keep pace with the increased demands of the airplane industry.

¶ Du Pont technical skill and experience will insure strict maintenance of the quality that has made DU PONT DOPE the standard for airplane surfaces.

Du Pont Chemical Works

E. I. du Pont de Nemours & Co., Owner

120 Broadway New York

Radium Luminous Material

SHINES IN THE DARK

SELF-LUMINOUS REQUIRES NO MAINTENANCE OVER A PERIOD OF YEARS

INNUMERABLE USES IN ITS ORIGINAL POWDERED FORM OR APPLIED WITH ADHESIVE

A SAFETY DEVICE FOR WAR

ON

MACHINE GUN, PISTOL AND RIFLE SIGHTS; RANGE SCALES; AUTOMATIC TELEPHONES; WIRELESS APPARATUS; NAVIGATING INSTRUMENTS OF ALL FLYING AND SAILING CRAFT; DECK CLOCKS; WRIST, STOP AND POCKET WATCHES; SIGNALS; PLOTTING BOARDS; ETC.

Radium Luminous Material Corporation

Fifty Five Liberty Street New York City

Fahrig Anti-Friction Metal

The Best Bearing Metal on the Market
A Necessity for Aeroplane Service

Fahrig Metal Quality has become a standard for reliability. We specialize in this one tin-copper alloy which has superior anti-friction qualities and great durability and is always uniform.

When you see a speed or distance record broken by Aeroplane, Racing Automobile, Truck or Tractor Motor, you will find that Fahrig Metal Bearings were in that motor.

FAHRIG METAL CO., 34 Commerce St., N.Y.

ROME AERONAUTICAL RADIATORS

Developed from years of experience in building all types of radiators.

They possess every feature and qualification necessary for a high grade product.

STRONG
EFFICIENT
DURABLE

Used on the best American flying machines.

Our engineering department is at your service.

Rome - Turney Radiator Company

Rome, N. Y., U. S. A.

DROP FORGINGS

THE WHITMAN & BARNES MANUFACTURING CO.

ESTABLISHED 63 YEARS

1000 WEST 120th STREET, CHICAGO, ILL.

ORDNANCE ENGINEERING CORPORATION

NEW YORK OFFICE
120 Broadway, Equitable Building

LONDON OFFICE
19 Queen Anne Chambers, Westminster, S. W.

Government Contractors : : Consulting Engineers

Manufacturers of Illuminating Shells, Trench Howitzers, Hand Grenades, etc., etc.

Naval and Military Appliances and Parts designed, developed and perfected

Designers and Builders of Military and Naval
AIRCRAFT

McADAMITE-ALUMINUM COMPANY

57-83 Isabella Ave. DETROIT, MICH.

Highest-Grade—Strongest

ALUMINUM CASTINGS

Tensile strength.....	44,250	lbs. Sq. In.
Compression	126,000	" " "
Transverse	87,200	" " "
Torsion	66,300	" " "
Fusing Point.....	1040	Degrees F

LARGE CAPACITY PLANT

Quick Deliveries Guaranteed

PREVENTS STALLING

FOXBORO
TRADE MARK

AIR SPEED INDICATORS

Tell the aviator at a glance if his machine is maintaining buoyancy, or stalling. It accurately measures the relative wind pressure, the force which keeps the plane in the air. It insures safe flying.

*Send for illustrative and descriptive Bulletin No. BF*110.

THE FOXBORO CO. **Foxboro, Mass., U. S. A.**

New York 50 Church St.	Chicago 1363 Monadnock Bldg.	Pittsburgh B. F. Jones Bldg.	Birmingham, Ala. 740 Brown Marx Bldg.
Philadelphia 1414 So. Penn. Sq.	St. Louis 1984 R. Exch. Bldg.	San Francisco 461 Market St.	Peacock Bros. 285 Beaver Hall Hill, Montreal

STIMPSON-RIVETS

WE MAKE SCREW HEAD NAILS AND RIVETS FOR EVERY PURPOSE.
EYELETS, HOOKS, GROMMETS AND WASHERS FOR SHOES, SHELTER TENTS, CORSETS, LEGGINS, MAIL BAGS.

70 FRANKLIN AVENUE 70 BROOKLYN, NEW-YORK

ACIERAL METAL

Light as Aluminum *Strong as Steel*

Non-corrosive by salt water

CASTINGS *RODS* *SHEETS*

Prompt Deliveries

ACIERAL CO. OF AMERICA

Main Office:
26 Cortlandt Street
NEW YORK CITY

Plant:
20 Orange Street
NEWARK, N. J.

THE RELIABLE HOUSE DUTTON

AEROPLANE FIR

WE HAVE SUPPLIED A LARGE QUANTITY OF DOUGLAS FIR FOR AEROPLANE PURPOSES.

Our facilities are of the best.

A. C. DUTTON LUMBER CORPORATION

Mills
SOUTH BEND, WASH.
TACOMA, WASH.

General Sales Department
SPRINGFIELD, MASS.

Wharves, Warehouses and Storage Yards
POUGHKEEPSIE, N. Y.

AVIATOR SUITS

Suit and Hood Complete $35.00

WIND PROOF WATER PROOF WEATHER PROOF

Sanders Aviator's suits absolutely wind and water proof made from heavy gabardine cloth—well lined—with hood to match.

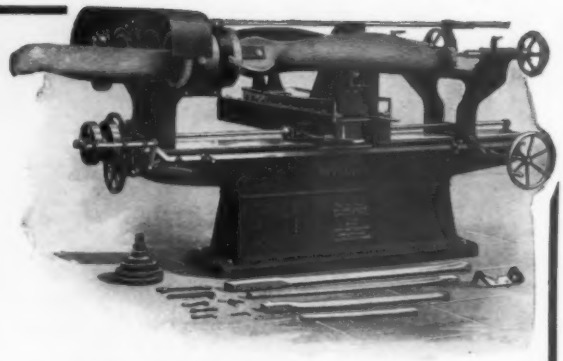
COMPLETE $35.00

Send for catalogue and samples

SANDERS COMPANY

218 INDIANA AVENUE INDIANAPOLIS, INDIANA

Tan Russian Leather Hood, Wool Lined, $5.00



Takes The Place of Eight To Ten Skilled Workmen

By actual test in one of the foremost aeroplane factories, the new Defiance Aeroplane Propeller Turning Lathe accomplished eight to ten times as much work as a skilled woodworker, and did it more accurately. With one man operating a number of lathes, each machine will pay for itself in a few months, and then start paying a daily profit of eight to ten times a skilled workman's wage.

Defiance Aeroplane Propeller Turning Lathe

automatically turns aeroplane propeller blades of any size—to any shape or pitch—and leaves only the final finishing to be done by hand. It will duplicate struts, as well as propellers, of irregular shape to exactness. Many months of successful operation has proven this machine beyond an experiment. Installations are everywhere being made by leading aeroplane and propeller manufacturers.

An illustrated and descriptive circular of this machine will be mailed upon request.

THE DEFIANCE MACHINE WORKS
DEFIANCE, OHIO, U. S. A.
NEW YORK CITY LONDON, ENG.

From an actual night photograph without retouching.

Taken with no light except the glow of Marvelite itself.

Aviation Barometers Equipped With

MARVELITE

self-luminous Radium compound of quality

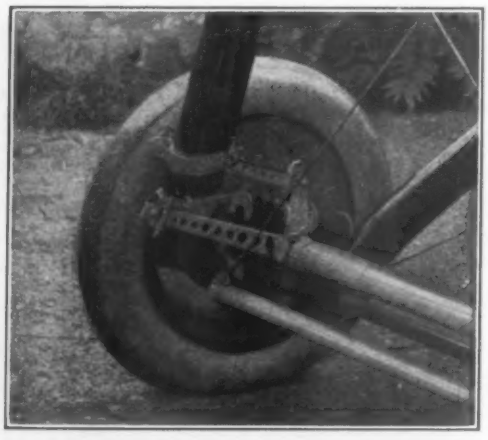
Are proving so useful and so entirely satisfactory that no manufacturer can longer afford to delay investigating the merits of this remarkable new material. Correspondence solicited, samples furnished and any reasonable demonstration gladly made for makers of barometers, compasses, sights, clocks and watches.

COLD LIGHT MFG. COMPANY
DENVER, COLORADO

Heavy Elastic Aviation Cord

We manufacture a full and complete line of heavy elastic aviation cord.

We are the originators and the largest manufacturers in the world of heavy elastic cord.



Standard H-3 equipped with our cord

J. W. WOOD ELASTIC WEB CO.
STOUGHTON, MASS.

METAL HOSE

For every Airplane Requirement

Write for specifications and prices

PENNSYLVANIA FLEXIBLE METALLIC TUBING COMPANY
Broad and Race Sts., Philadelphia
New York Boston Chicago Detroit Cleveland

DOEHLER

BABBITT-LINED BRONZE

BEARINGS

have been used for years with the utmost success by the leading motor manufacturers in the automobile and airplane industries.

DOEHLER DIE-CASTING CO.
MAIN OFFICE AND EASTERN PLANT
WESTERN PLANT BROOKLYN, N.Y. NEW JERSEY PLANT
TOLEDO, OHIO. NEWARK, N.J.

Also Die-Cast Babbitt Bearings, Die-Castings in Brass & Bronze Aluminum and White Metal Alloys

Boeing Airplane Co.

AIRPLANES
ACCESSORIES
SCHOOLING

GENERAL OFFICES:
Hoge Building - Seattle, Washington

Sturtevant
(REG. U.S. PAT. OFF.)
Aeroplane Company

Jamaica Plain Boston

Member Manufacturers Aircraft Association

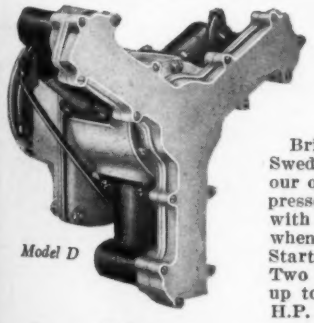
CAPITAL INTERNAL GRINDER **STAMPINGS** JIGS TOOLS DIES

WE realize *in air* or *at sea* there should be *no faulty* material. All machine parts must be made *right* and perform their functions *properly*, hence we have equipped our new plant to turn out work of the highest quality. We offer our facilities to you and trust we may be of service.

Will you give us a trial?

LANSING STAMPING & TOOL CO.
LANSING, MICHIGAN

American Automotive Company
Manufacturers
Aeroplanes and Hydro-Aeroplanes
FOURTH AND WATER STREETS
GLOUCESTER, N. J.
Request catalogs and prices from all manufacturers in regard to parts that will meet U. S. Govt. requirements.


Model D

The "Perfect Starter" Booklet Sent Free on Request

Tested and Approved by U. S. Gov't.

British, Dutch, Norwegian, and Swedish Governments, as well as our own, have approved this compressed-air starter. Interference with engine is impossible, as when not in use the Perfect Starter leaves motor entirely free. Two models: "C" for engines up to 250 H.P.; "D" up to 150 H.P. Both self-charging.

Booklet Free on Request.
MOTOR-COMPRESSOR CO.
NEWARK, N. J., U. S. A.

Aeromarine Plane & Motor Co.
Manufacturers of
Aeroplanes and Motors
Member of Aircraft Manufacturers Association
New York Office: Times Building
Telephone, Bryant 6147

AMERICAN PROPELLER & MFG. CO.
TRADE MARK
PARAGON
BALTIMORE MARYLAND U.S.A.

"PRUDENTIAL"
HANGARS & GARAGES
PURELY PORTABLE
IN METHOD OF ERECTION
SCIENTIFICALLY CONSTRUCTED
FOR STORAGE AND INDUSTRIAL BUILDINGS
GALVANIZED STEEL COVERING
STRUCTURAL STEEL FRAMING
"BOLTING METHOD"
1/3 LESS STRUCTURAL STEEL USED DUE TO THE STRENGTH OF OUR FORMED MEMBERS IN OUR WALL AND ROOF CONSTRUCTION.
MANUFACTURED BY The C. D. PRUDEN COMPANY, BALTIMORE, MD.

BALL AND ROLLER BEARINGS
Annular—Single and Double Row
Ball Thrust—All Types Taper Roller—Standard
Roller Thrust—Collar Type Pressed Steel—All Types
Sole Agents for the U. S. of
The Bowden Patent Wire Mechanism
for the Transmission of Reciprocating Motion Through a Flexible and Tortuous Route.
THE GWILLIAM COMPANY
ENGINEERS
NEW YORK . . 253 W. 58th Street, (at Broadway)
PHILADELPHIA . . . . . 1314 Arch Street

LEYGRAND & CO.
120 Broadway, New York
MILL AGENTS
ALUMINUM SHEETS
Screw Stock, Rod and Wire

VENEERED PANELS
FOR
AIRPLANE and HYDROPLANE CONSTRUCTION
Send for Samples Chemically Treated Which Increases
WATERPROOFNESS
NEW JERSEY VENEER CO., Paterson, N. J.
Telephone, 3620 Paterson

For Your Flying ← Boats Use
All the prominent builders of flying boats use this glue in combination with linen between the veneer of the diagonal planking on all their flying boats, pontoons and floats. It is not only waterproof and elastic but will waterproof and preserve the linen indefinitely. Experience has shown that when this glue is used, owing to its elasticity, the inside layer of diagonal planking will remain perfectly water tight although the outside layer may be badly broken.
L. W. Ferdinand & Co.
152 Kneeland Street
Boston, Mass., U. S. A.

PROPELLER SERVICE
By an organization equipped to take hold of your problems. QUANTITY PRODUCTIONS. Let us advise on your specifications.
W. A. DOYLE, TRENTON, N. J.

EXCELSIOR PROPELLERS
Propellers of the greatest efficiency and highest quality. Unequalled in accuracy and reliability.
Excelsior Propellers are used by all the leading aviators. Only one quality—the best.
Complete stocks on hand for prompt shipment
Write to-day for booklet
EXCELSIOR PROPELLER COMPANY
ST. LOUIS, MO.

PUNCH PRESS WORK AND STAMPINGS

Specializing particularly in Aeroplane work where accurate workmanship is absolutely necessary.

Also—Aeroplane Machine Work.

CENTURY TELEPHONE CONSTRUCTION COMPANY

BUFFALO, N. Y.

Oil Proof—Gasoline Proof Water Proof VELLUMOID GASKETS

Tough—Compressible—Flexible

If you are not familiar with *Vellumoid* have us send you samples—either sheet or gaskets cut as per your blue prints.

Expert Gasket Cutting department. Quick service

Fibre Finishing Co., 27 State St., Boston

Special Sheet Metal Work

—for—

Airplanes

Precise Work Executed from Blue Prints or specifications . . . . .

The Auto-Aero Sheet Metal Works

45 High Street, New Haven, Conn.

PONTOONS

and

FLYING BOAT HULLS

Built from your designs or from ours

Palmer-Simpson Corp.

Saranac Lake, N. Y.

BUFFAIRO

AIR-SCREWS

of

PROVEN PROFICIENCY

Detailed information upon request

BUFFALO AEROPLANE CORP.

BUFFALO, N. Y. U. S. A.

Cable Address, "BUFFAIRO"

Type "B1"

Type "B2"

Aeroplane Cylinder Forgings

We make a specialty of hollow forging in dies under our hydraulic presses, aeroplane cylinder forgings of high and low carbon O.H. or alloy steels.

We have furnished cylinder forgings to practically all the engine builders in the United States.

Also Propeller Hubs, Flanges and Shafts, etc.

Miscellaneous steam hammer and hydraulic press die forgings of all types.

Quick service our specialty

TIOGA STEEL & IRON COMPANY

52nd & Grays Avenue Philadelphia, Pa., U. S. A.

WOOD WORKING MACHINERY

SPECIALLY ADAPTED

FOR

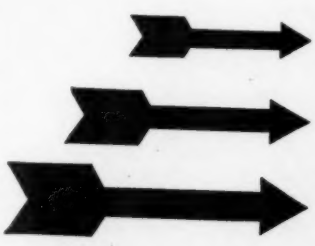
Aeroplane Factories

Write for information catalogue No. 97

OLNEY & WARRIN

406-412 Broome Street

Tel. Spring 4425 NEW YORK, N. Y.



Screw Machine Products

Let us quote on your requirements for whatever you need in this line.

Compliance to specifications, accurate work, and satisfaction guaranteed.

Any work up to 2¼" diameter can be handled.

THOS. H. DALLETT CO.

PHILADELPHIA, PA.

Automotive Engineering Company

CONSULTING AERONAUTICAL ENGINEERS

AEROPLANE *and* MOTOR
DESIGN *and* DEVELOPMENT
AIRCRAFT FACTORY LAYOUT
ECONOMIC PRODUCTION PROCESSES

120 S. State Street Chicago, Illinois

JORGE VILLEGAS D.

Civil and Mechanical Engineer

SOLICITOR AND EXPERT ON SOUTH-AMERICAN PATENTS

Power Plants, Pumping Stations, Pipe Lines. Reports on Copper and Coal Mines in Chile and Bolivia

Merced 720-726. *Casilla 1952*

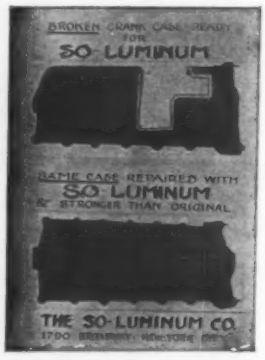
SANTIAGO, CHILE

DON'T SCRAP ALUMINUM PARTS

Save them with

SO-LUMINUM

new great "3 in 1" brazing, welding and soldering compound, stronger than aluminum or its alloys. A perfect substitute for acetylene welding in one-quarter time and cost. Use gasoline torch or gas blower. No flux. Booklet on request. Sample bar, $1.00. Used by the United States Army and Navy, auto and aero companies, and indorsed by the British Munitions Board.



SO-LUMINUM MFG. & ENG. CO., Inc.
Room 25, 1790 Broadway New York City

The Beam Airplane Company

(INCORPORATED)

Announce that they are in a position to accept a few students in their Aviation School.

CURTISS *and* EUROPEAN MOTORS
TRACTOR *and* PUSHER MACHINES
CONSTRUCTION EXPERIENCE
FEES *and* LIVING EXPENSES REASONABLE
NO CHARGE FOR BREAKAGE

Correspondence Invited

THE BEAM AIRPLANE COMPANY
CELINA OHIO

The United States Government has Specified

Radium Luminous Compound

for use on aircraft instruments. It is the best luminous material the world affords, and is giving perfect satisfaction in innumerable uses.

Our own experts apply Radium Luminous Compound to dials, navigating instruments, etc.

WRITE TODAY

Radium Dial Company
Forbes and Meyran Avenues, Pittsburgh, Pa.

C. A. Herrmann

DESIGN AND CONSTRUCTION

Covering All Branches of Aviation

Bath, N. Y.

Classified Advertising

10 cents a word, minimum charge $2.00, payable in advance. Address replies to advertisements with box numbers, care of AVIATION AND AERONAUTICAL ENGINEERING, 120 West 32d Street, New York.

WANTED—Experienced metal bench hands, mechanics, woodworkers and assemblers for airplane construction. Thomas-Morse Aircraft Corporation, Ithaca, N. Y.

FOR SALE—8-cylinder 4" x 4" Hall-Scott motor complete with radiator, two propellers, Bosch ignition, in good condition, $850. Apply Hoffar Motor Boat Co., Vancouver, B. C.

FOR SALE—Two 90-hp. 8-cylinder motors and propellers, A1 condition, also large flying boat with or without motor. Good price to quick buyer. Box 98.

WANTED—Reliable, experienced airplane propeller builder. Must have ample glue room experience. Address with reference and length of experience in first letter, Box 61.

GRADUATE of high school trade course, two years mechanical drafting experience, desires position with reliable concern. Address Box 100.

FOR SALE—Avro seaplane 36' spread 5' chord, two place, single pontoon, 100-hp. 6-cylinder Roberts, will get off water with two passengers within 200 yards, new this year, perfect condition, will demonstrate, price $2300. Apply Hoffar Motor Boat Co., Vancouver, B. C.

Aeronautical Trade Directory

AVIATION AND AERONAUTICAL ENGINEERING will furnish information and addresses of all companies listed below. Names of Advertisers in this issue are printed in heavy face type.

ACETYLENE WELDING AND CUTTING

Davis-Bournonville Co.
Searchlight Co.

ACCESSORIES AND INSTRUMENTS

DuVivier, Earnest J.
Mote-Meter, The, Co.
Sperry Gyroscope Co.
Standard Aeronautical Co.
Taylor Instrument Companies

AIRPLANES

Aeromarine Sales and Engineering Corp.
American Automotive Co.
Automotive Engineering Co.
Bates Aeroplane Co.
Benoist Aeroplane Co.
Boeing Airplane Co.
Burgess Co., The
Carter Bros. Aeroplane Co.
Curtiss Aeroplane and Motor Corp.
Dayton Wright Airplane Co.
Flint Aircraft Co.
Fowler Airplane Corp.
Gallaudet Aircraft Corp.
Hall, J. Robinson
Heinrich, The A. S. Corp.
Herrmann, Chas. A.
Janney Aircraft Co.
L. W. F. Engineering Co.
Lanzius Aircraft Co.
Lawrence-Lewis Aeroplane Co.
Lawson Aircraft Co.
Lewis & Vought Corp.
Longren Airplane Co.
Pacific Aero Products Co.
Ordnance Eng. Co.
Richardson Aeroplane Corp., Inc.
Rogers Construction Co.
Rumsey Aeroplane Co.
Smith, Kyle, Aircraft Co.
Standard Aero Corporation.
Sturtevant Aeroplane Co.
Thomas-Morse Aircraft Corp.
Walden-Hinners Co.
Williams Aeroplane Co.
Wittemann-Lewis Aircraft Co.
Wright-Martin Aircraft Corp.
Lewis G. Young.

AIRPLANE ENGINES

Aeromarine Plane and Motor Co.
Automotive Engineering Co.
Bournonville Motors Corp.
Cleveland Aero Motor Co.
Curtiss Aeroplane and Motor Corp.
Duesenberg Motors Corp.
General Ordnance Co.
General Vehicle Co.
Gyro Motor Co.
Hall, J. Robinson
Hall-Scott Motor Car Co.
Harriman Aircraft Motors Co.
Knox Motors Co.
Maximotor Co.
Miller, Harry A., Mfg. Co.
Orio Motor Co.
Packard Motor Co.
Roberts Motor Mfg. Co.
Sterling Engine Co.
Sturtevant, B. F., Co.
Thomas-Morse Aircraft Corp.
Union Gas Engine Co.
Wisconsin Motor Mfg. Co.
World's Motor Co.
Wright-Martin Aircraft Corp.

AIRPLANE PARTS

Auto-Aero Sheet Metal Co.
Century Telephone Construction Co.
Erie Specialty Co.
Levett, Walker M. Co.
New Jersey Veneer Co.
Pressed & Welded Steel Prod. Co.
Rogers Construction Co.
Standard Parts Co.

ALUMINUM

Aceral Co. of America
Aluminum Castings Co.
Aluminum Co. of America
American Metal Co., Ltd.
Leygrand & Co.
McAdamite-Aluminum Co.
So-Luminum Mfg. & Eng. Co. (Solder)
United Smelting & Aluminum Co.

AVIATION SCHOOLS

America Trans Oceanic Co., The
Atlantic Coast Aeronautical Station
Beam School of Aviation
Curtiss Training Schools
Davenport Aviation School
Dodge School of Aviation
Flint Aircraft Co.
Hall Flying School
Moler Aviation Instructors
Stinson School of Aviation
Thomas-Morse Aircraft Corp.
Williams Aviation School

BALL BEARINGS

Gwilliam Co., The
Gurney Ball Bearing Co.
Hess-Bright Mfg. Co
New Departure Mfg. Co.
Norma Company of America.
S. K. F Ball Bearing Co.
U. S. Ball Bearing Mfg. Co.

BALLOONS; DIRIGIBLES

Connecticut Aircraft Co.
Custer Specialty Co. (Statoscope)
French-American Balloon Co.
Gas Engineering Co. (Gas Plants)
Goodyear Tire and Rubber Co.
Knabenshue Aircraft Corp.
United States Rubber Co.

BAROGRAPHS AND BAROMETERS

Green, Henry J.
Haustetter, A.
Sussfield & Lorch
Taylor Instrument Companies

BATTERIES

Electric Storage Battery Co.

BEARING METALS

American Bronze Co.
Fahrig Metal Co.
Levett, Walker M. Co.

BUSHINGS

Bound Brook Oil-Less Bearing Co.

CARBURETORS

Miller Carburetor Co.
Stromberg Motor Devices Co.
Wheeler and Schebler
Zenith Carburetor Co.

CLOCKS AND WATCHES

Ingersoll, Robt. H., and Bro.
Chelsea Clock Co.
Depollier, J., & Son
Waltham Watch Co.

CLOTHING

Abercrombie & Fitch
Rogers, Peet & Co.
Sanders Co.
Spalding, A. G., & Bros.

COMPASSES

Sperry Gyroscope Co.
Taylor Instrument Companies

DOPE AND VARNISH

Adams & Elting Co.
American Emaillite Co.
Chemical Products Co.
Conover, The C. E., Co.
DuPont Chemical Works
Flexible Compound Co.
National Aeroplane Co.
Pratt & Lambert
Standard Varnish Works
Valentine & Co.
Weeks & Co.

DRIFT INDICATOR

Sperry Gyroscope Co.

DRY KILNS

Cutler Dry Kiln Co.
Grand Rapids Veneer Works

DYNAMOMETER

Sprague Electric Works

ENGINE PARTS

Akimoff, N. W.
Allegheny Forging Co.
Burd High Compression Ring Co.
Dallet, Thos. H. Co.
Doehler Die Casting Co.
Erie Specialty Co.
Fibre Finishing Co.
Gifford, Leland Co.
Gill, P. H., & Sons
Hydraulic Pressed Steel Co.
Levett, Walker M., Co.
Park Drop Forge Co.
Standard Parts Co.
Taft-Pierce Mfg. Co.
Tioga Steel & Iron Co.
Williams, J. H., & Co.
Whitman & Barnes Mfg. Co.
Wyman-Gordon Co.

ENGINEERING

Automotive Engineering Co.
Ordnance Engineering Co.
Villegas, Jeorge

FABRICS

Courtral Mfg. Co.
Kursheedt Mfg. Co.
Lamb, Finlay & Co.
McBratney, Robt. & Co.
Scott, Hutchison Co.
Whitman, Clarence & Co.

FIRE EXTINGUISHERS

Fyr-Fyter Co., The
Johns-Manville Co., H. W.
Pyrene Mfg. Co.

GAGES

Crosby Steam Gage & Valve Co.
Foxboro Co., The, Inc.
United States Gage Co.

GASKETS

Fibre Finishing Co.

GLUE

Ferdinand, L. W., & Co.
Baeder & Adamson.

GOGGLES

Strauss & Buegeleisen

HANGARS

American Bridge Co.
Anchor Corrugating Constr. Co.
Ashley Steel Bldg. Co.
Howell, Field & Goddard, Inc.
Keasby & Mattison
Milliken Bros.
Pruden, C. D. Co.
Virginia Bridge & Iron Co.

LIFE PRESERVERS

Universal Safety Mattress Co.

LUMBER

Alcock Co., John L.
American Balsa Corp.
Chetham Lumber Co.
Delatour, J.
Dutton, A. C. Lbr. Corp.
Ludlow, Israel
Mengel, C. C., & Bros. Co.

LUMINOUS COMPOUND

Cold Light Mfg. Co.
Radium Dial Co.
Radium Luminous Material Corp.

MACHINERY, METAL WORKING

Dalton Mfg. Corp.
Warner & Swasey Co.

MACHINERY, WOOD WORKING

Defiance Machine Works
Fox Machine Co.
Olney & Warrin

MANIFOLDS

Ajax Auto & Aero Sheet Metal Co.

MAGNETOS

Bosch Magneto Co.
Berkshire Magneto Corp.
Ericsson Mfg. Co.
Remy Electric Co.
Splitdorf Electrical Co.

METALS

Aceral Co. of America
American Vanadium Co.
Bethlehem Steel Co.
Detroit Pressed Steel Co.
Federal Pressed Steel Co.
Garland Ventilator Co.
Gueder, Paeschke & Frey Co.
Levett, Walker M. Co.
So-Luminum Mfg. Co.

MODEL AIRPLANES

Ideal Aeroplane Supply Co.
Wading River Mfg. Co.

MOTORCYCLES

Excelsior Motor Mfg. Supply Co.
Harley-Davison Co.
Hendee Mfg. Co.
Henderson Motorcycle Co.

OILS AND LUBRICANTS

Baker Castor Oil Co.
Graphite Lubricant Co.
Gulf Refining Co.
Sheppard Ideal Oil Co.
Standard Oil Co.
Swan & Finch
Texas Co.
Vacuum Oil Co.

OIL PUMPS

Wayne Oil Tank & Pump Co.

ORDNANCE

Driggs-Seabury Ordnance Corp.
General Ordnance Co.
Maxim Silencer Co.
Savage Arms Co.

PACKING

Fibre Finishing Co.

PHOTOGRAPHY

Brock, Arthur, Jr.
Herbert & Huesgen Co.

PISTONS

American Piston Ring Co.
Levett, Walker M., Co.

PONTOONS

Niagara Boat Co.
Palmer-Simpson Corp.
Welen Marine Equipment Co.

PROPELLERS

American Propeller & Mfg. Co.
Aviauto Mfg. Co.
Buffalo Aeroplane Corp.
C. M. O. Physical Laboratory
Doyle, W. A.
Excelsior Propeller Co.
Harriman Aircraft Motors Co.
Hazel Walnut Propeller Co.
Lang Propeller Co.
Schweizer & West Mfg. Co.

PYROMETERS

Foxboro Co., The, Inc.
Shore Instrument & Mfg. Co.
Taylor Instrument Companies

RADIATORS

Auto Radiator Mfg. Corp.
Ajax Auto & Aero Sheet Metal Co.
A-Z Co.
Bush Mfg. Co.
El Arco Radiators Co.
English & Mersick Co.
Livingston Radiator Co.
Rome-Turney Radiator Co.

RIVETS

Stimpson, Edwin B. Co.

SCLEROSCOPE

Shore Instrument & Mfg. Co.

SHOCK ABSORBERS

Dural Rubber Corp.
Wood, J. W. Elastic Web Co.

SPARK PLUGS

Champion Ignition Co.
Johns-Manville Co., H. W.
Pyro Ignition Co.
Rajah Auto Supply Co.
Splitdorf Electrical Co.

SPEED INDICATORS

Foxboro Co., The, Inc.
Johns-Manville Co., H. W.
Stewart Warner Speedometer Corp.

STABILIZERS

Greene Aeronautical Co.
Martin Arodynamic Stabilizer.
Sperry Gyroscope Co.

STAMPINGS

Lansing Stamping & Tool Co.

STARTERS

Bijur Motor Lighting Co.
Christensen, The, Engineering Co.
Dayton Engineering Laboratories Co.
Motor Compressor Co.
Northeast Electric Co.
Wagner-Hoyt Electric Co.

TACHOMETERS

Johns-Manville Co., H. W.
Nelson Blower & Furnace Co.
Queen-Gray Co.
Stewart Warner Speedometer Corp.
Veeder Mfg. Co.

TANKS

Janney, Steinmetz & Co.

TELEPHONES

General Accoustic Co. (Aviaphone).
Streator Electric Co.
Telautograph Corp.
Western Electric Co.

THERMOMETERS

Foxboro Co., The, Inc.
Taylor Instrument Companies

TIRES AND RUBBER

Dural Rubber Corporation.
Goodyear Tire & Rubber Co.
Hodgman Rubber Co.
United States Rubber Co.

TOOLS

Browne & Sharpe
Hall-Scott Motor Car Co.
Lansing Stamping & Tool Co.

TRUCKS AND TRAILERS

Federal Motor Truck Co.
Four Wheel Drive Auto Co.
Nash Motors Co.
Packard Motor Car Co.
Sechler & Co., The
Service Motor Truck Co.
White Co.

TUBING

Empire Art Metal Co.
Frasse, Peter A., & Co.
Pennsylvania Flexible Metallic Tubing Co.

TURNBUCKLES

Aero Mfg. & Accessories Co.
C. E. Aeroplane Works
Dayton Metal Products Co.
Dillner-Meyer Mfg. Co.
Erie Specialty Co.
National Aeroplane Co.
New York & Hagerstown Metal Stamping Co.
Standard Screw Co.

WHEELS

Ackerman Wheel Co.
Mott Wheel Works
National Wire Wheel Works.
Wire Wheel Corporation of America.

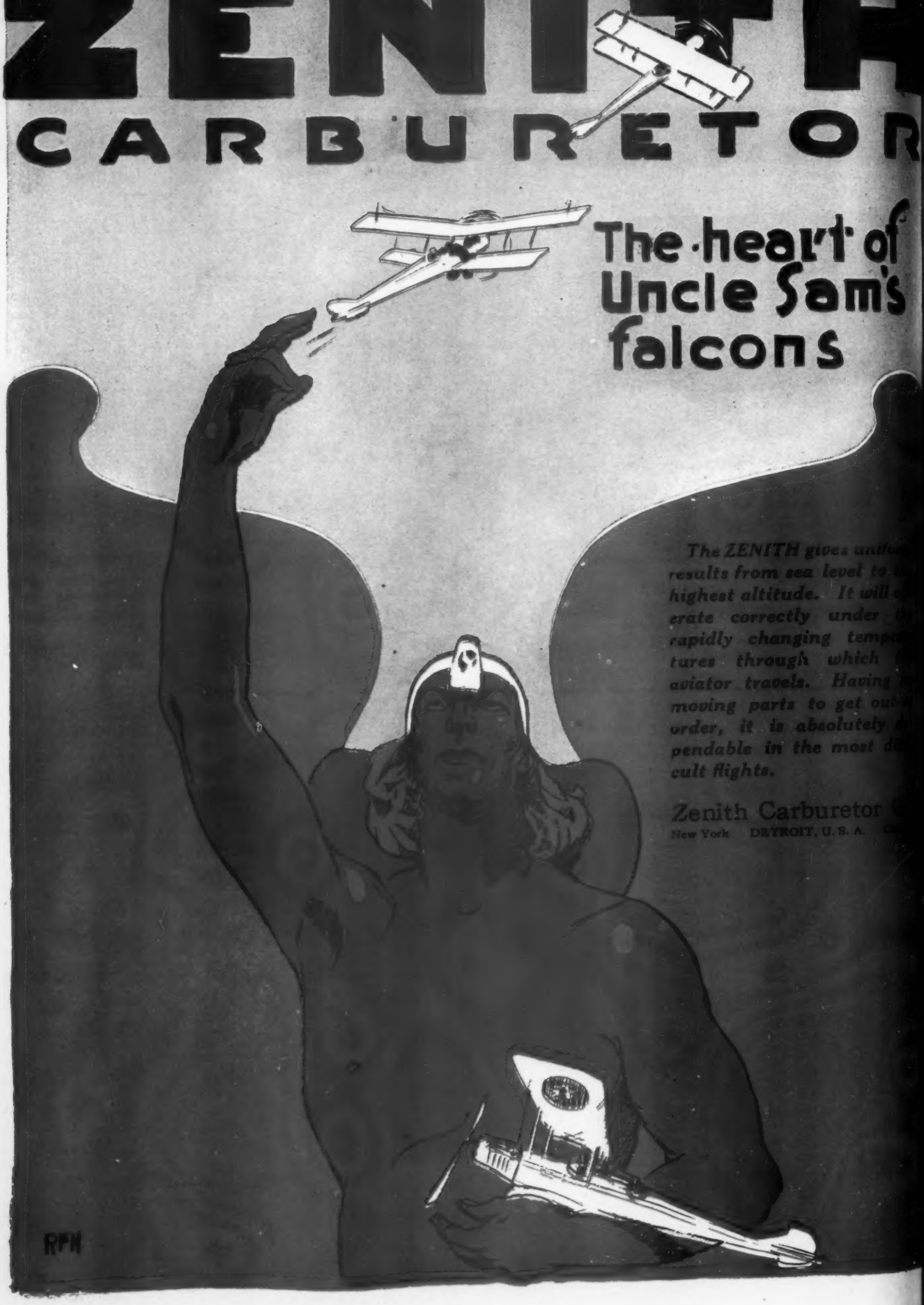
WIRE

American Steel and Wire Co.
Century Telephone Construction Co.
Electric Cable Co.
Roebling's, John A., Sons
Simplex Wire and Cable Co.

WIRELESS

American Radio & Research Corp.
American Wireless Tel. Co.
Cutting & Washington.

ZENITH CARBURETOR


The heart of Uncle Sam's falcons
The ZENITH gives uniform results from sea level to the highest altitude. It will operate correctly under the rapidly changing temperatures through which the aviator travels. Having no moving parts to get out of order, it is absolutely dependable in the most difficult flights.
Zenith Carburetor Co.
New York DETROIT, U. S. A. Chicago
RFH

Two-Direction Thrust Hess-Bright Ball Bearing of the Type used on Airplane Propeller Shaft Application

HESS-BRIGHT'S CONRAD PATENTS ARE THOROUGHLY ADJUDICATED

SCOUT-PLANES carry observers who locate masked batteries and map the country behind the enemy lines. Upon their safe return and the speed made may depend the lives of thousands.

And that safe return with speed is impossible without certainty of power production and transmission for the mounts driven by those observers' pilots.

The power of an airplane's motor determines its value; the continuity of that power, its dependability.

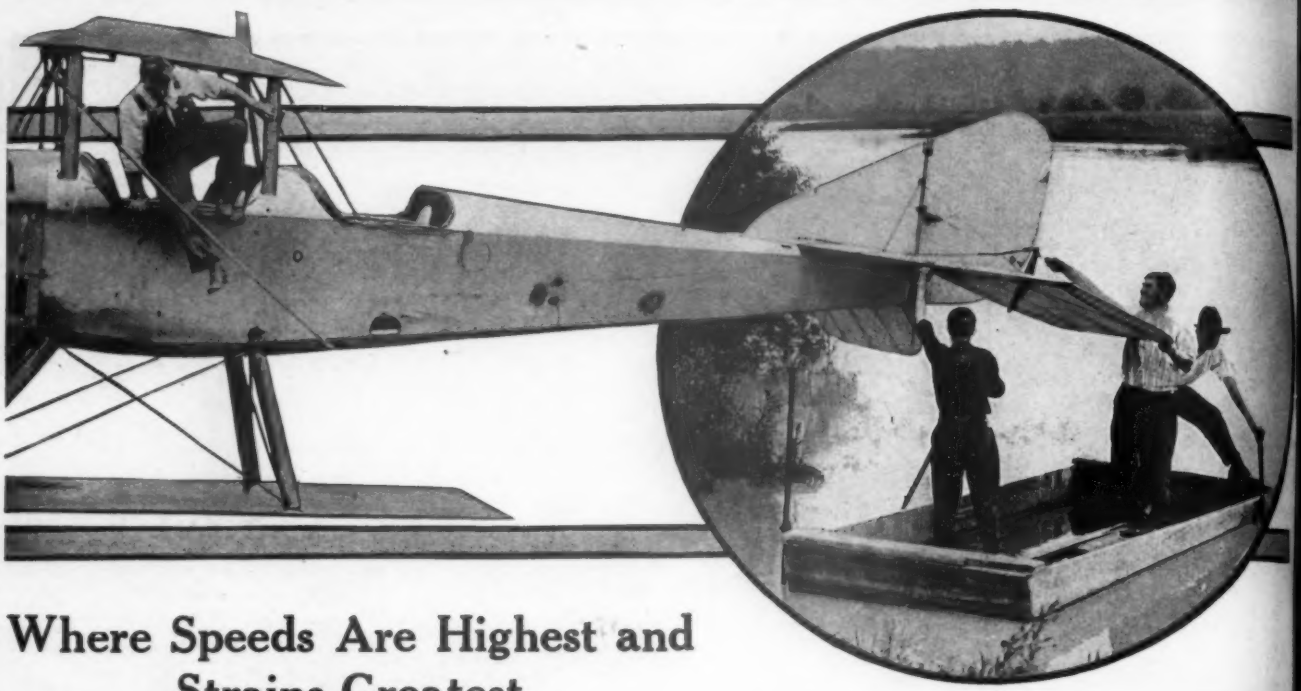
Hess-Bright Ball Bearings will increase power through cutting friction down, and assure its continuity through the excellence of their manufacture.

Government orders largely specify Hess-Brights.

THE HESS-BRIGHT MANUFACTURING COMPANY

PHILADELPHIA, PA.

WILLIAMS PRINTING COMPANY, NEW YORK

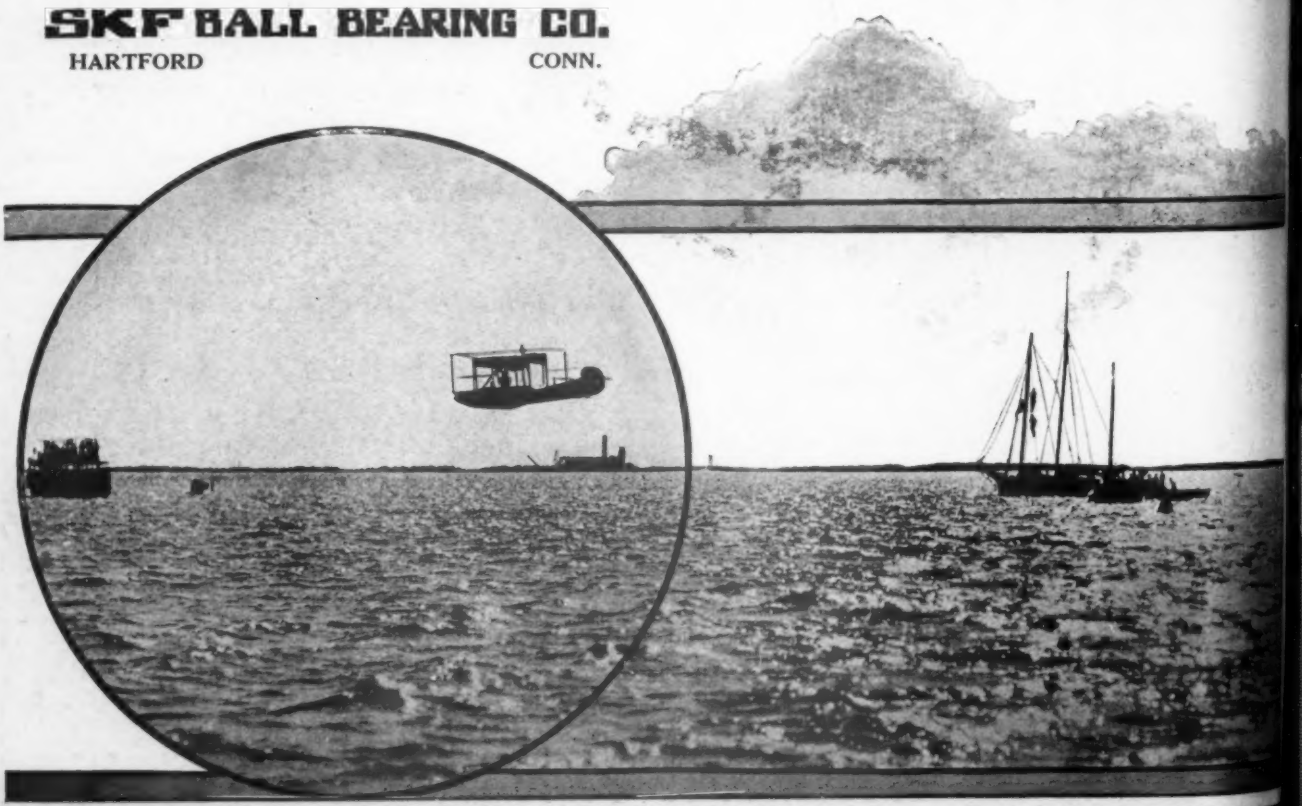


Where Speeds Are Highest and Strains Greatest

The airplanes that are hovering over the enemy's lines cannot afford to take a chance with inefficient bearings—nor can they risk a hot bearing—or even lubrication trouble. Every thing must work dependably at high speed.

Particularly on propeller shafts, SKF has long been recognized as particularly advantageous. Subject to whip and throw—the shaft deflections caused by the warp and weave of the planes, which puts heavy strains on the bearings—are automatically absorbed by SKF without binding strains or wear.

SKF
BALL BEARINGS

Safety First-Self Alignment

SKF BALL BEARING CO.
HARTFORD CONN.